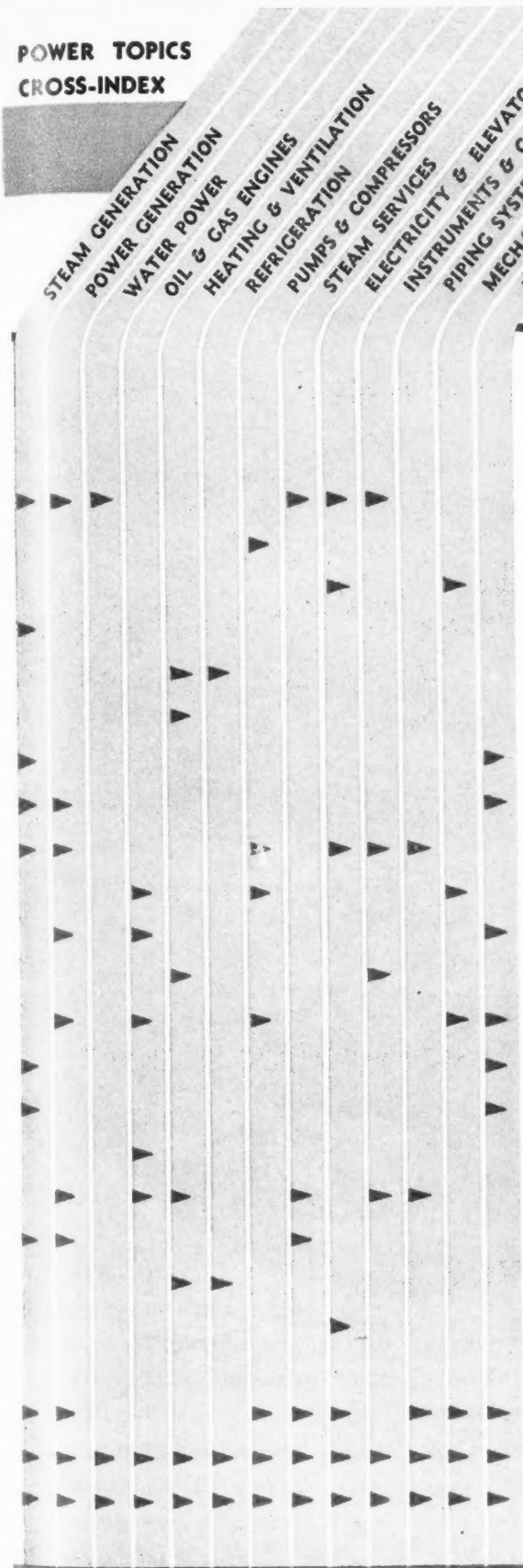

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NOVEMBER, 1935

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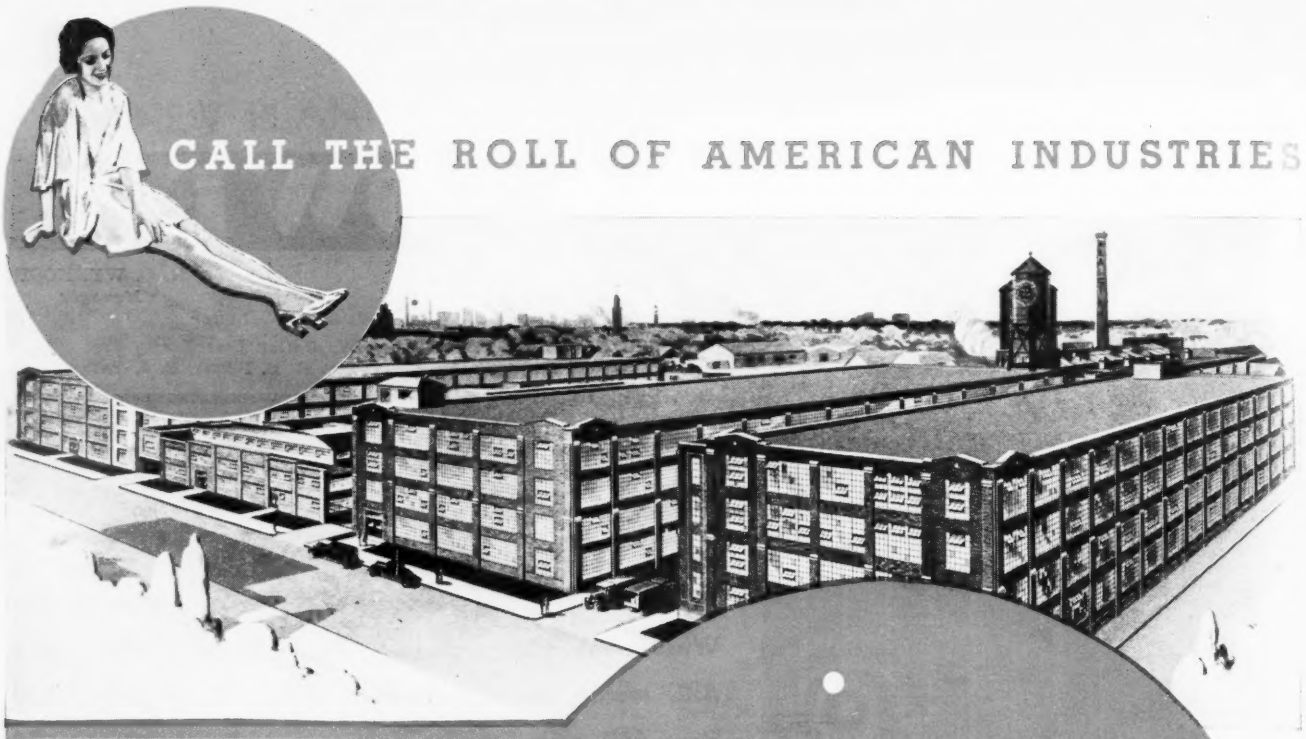

REAL SILK PLANT ENGINEER USES WROUGHT IRON for Corrosive Services

● Two particular pipe services in the Indianapolis plant of the Real Silk Hosiery Mills, Inc., world's largest manufacturer of silk hosiery for men and women, call for the corrosion resistance and economy that wrought iron gives. In these services—water well casing and steam return lines—wrought iron has proved, over a period of years, its corrosion resistance and low cost-per-year.

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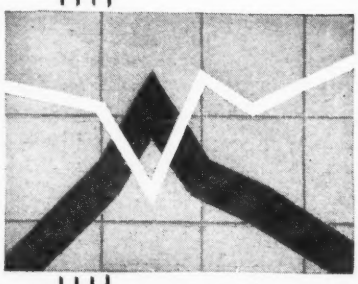


CLEARING SKIES

AFTER some early and not too successful attempts to date the end of the depression, I withdrew to the safer plan of extreme caution in prediction, confining myself mainly to reporting immediate and obvious business trends. Thus, at various times in recent months I have pointed to the indisputable fact of constantly improving business, but have taken care not to predict further ahead than you can see a fair-sized jack o'lantern on Halloween.

In recent weeks, however, the evidences of returning prosperity have been piling up so insistently that it seems no longer reasonable or fair to assume that we cannot see a clear road to the top of the next hillock. We can.

It is not now, and may never be, safe to predict unending years of prosperity, once "business is back to normal." Who can yet say that man has learned how to banish the business cycle? But neither is it good horse sense to expect rain tonight or tomorrow when winds have shifted from easterly to northwest, skies are clearing and barometer rising. So I predict good weather immediately ahead.

Probably that is as far as an engineer should go in the matter of business prediction. Yet he cannot help but be heartened by the fact that trained and specialized business observers feel safe today in making broader forecasts. I quote the final paragraph of *Business Week's* recent editorial, "We Have Turned the Corner":

"Every business indicator is turning up. Courage and confidence are returning. Every economic force is pressing toward renewed activity. We are undoubtedly well started on the upward swing of a long turn in the business cycle. Those corporations which are quickest, bravest, and most intelligent now in developing new markets will profit most in the end."

After 10,000 miles of editorial travel in the last seven months, and resulting contact with innumerable men and organizations, I have seen nothing East, West, North or South that makes this appear an unreasonable optimism. In the last six weeks, particularly, I have seen solid progress everywhere.

Never before has America been so well prepared for returning prosperity. Throughout the lean years engineers and business men have grown many a crop of ideas, only to plow them back into product design and improved organization because there were no outside takers. As a result, the soil from which today's business is springing is more fertile than ever.

New and wonderful consumer products are ready to meet the pent-up demand for finer living—better cars, radios and prepared foods —new building materials, better home appliances, finer clothes—speedier transportation.

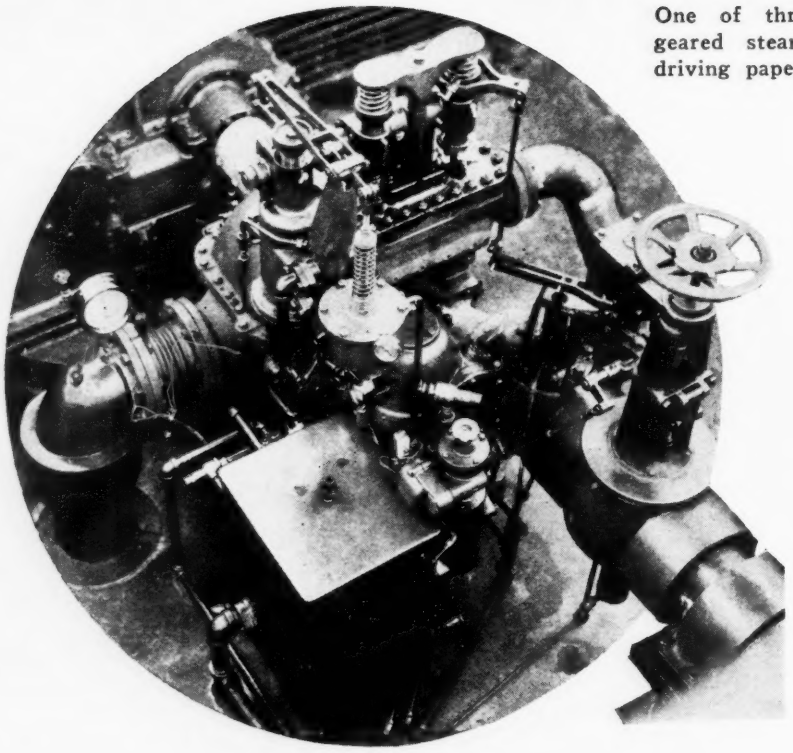
Yet few of these things could reach their destination if the means were not at hand to make the pay envelope cover them through lower manufacturing costs. Here too all is ready—better production machinery and processing equipment, machine tools of superlative design, power equipment enormously improved.

This great industrial mechanism has already started to function and is gaining momentum day by day. And every part of it gives the alert engineer his opportunity to win his share.

As never before engineers will be judged by their ability to produce a better product at lower cost. With fifty cents out of every power dollar wasted in American industry today, every power engineer faces an open road to better pay, greater security and prestige.

Philip Swain

Editor



One of three 475-hp. geared steam turbines driving paper machines

CUTS STEAM COSTS 60 Per Cent

A large pulp and paper company by intelligent modernization has maintained its plant up-to-date, cut steam costs 60% with comparable savings in production costs, and has established a world record for safe operation

AT WOODLAND, Me., the St. Croix Paper Co. operates a 200-ton per day newsprint mill. The company performs all operations from felling the trees for pulpwood to finishing rolls of newsprint. Even though the mill was started in 1905 it is still operating at low cost, having been kept up-to-date by a process of modernization to meet demands for increased production and to take advantage of new developments that reduced operating costs. This modernization policy applies to steam and power generation as well as to manufacturing processes.

While making an enviable record for low-cost operation, the company has won the national and state safety awards for the last four years in the pulp and paper industry. To date the company has operated for over 3,000,000 man-hours without a lost-time accident.

What this company has accomplished in safety is something to which every manufacturer may well give serious consideration. Organized work in safety at this plant began in January, 1927. In 1926, with an average of 503 employees, there were 85 lost-time accidents. This was reduced to 32 in 1927 and to 8 in 1928 and to none in 1932. Since Sept. 21, 1931, no lost-time accidents have occurred with an average of 400 employees.

Power and steam for the mill are supplied by hydro and fuel-burning plants. In 1923 the three paper machines were individually driven by 350-hp. steam engines. At this time production threatened to outstrip existing steam-generating facilities. Seven old h.r.t. boilers were replaced by two water-tube boilers with underfeed stokers. This gave a boiler plant comprising three water-tube boilers with underfeed stokers, one old hand-fired boiler used only in emergencies, one refuse-fired boiler, and a 6,000-kw. electric-steam generator. The latter was installed to utilize excess power, from the two hydro plants totaling 11,200 kw., during high-water periods and week-end shutdowns.

Following this change the paper machines were speeded up. This required replacing their steam engines with 450-hp. geared steam turbines. A 600-kw. turbine-generator was installed to help the hydro-electric plants supply electric load during low water, groundwood capacity having been increased by installing motor-driven grinders.

By 1930 production had increased until power facilities were insufficient to meet demands in low-water periods. It became necessary to store ground wood during high water so that grinder load could be reduced during times of insufficient water. Studies made of conditions showed that large savings could be made by installing a high-pressure boiler and increasing power-generating capacity, providing this capacity would permit the mill to operate full capacity without storing ground wood.

This development included a 450-lb. pulverized-coal-fired Wickes boiler and a 3,000-kw. General Electric back-pressure turbine-generator, the latter acting as a reducing valve between the 450- and 110-lb. steam mains. The new boiler is installed in space occupied by the old hand-fired unit.

This boiler is rated 100,000 lb. per hr., maximum, at 450 lb. gage and 725 deg. F. total temperature, and has supplied up to 110,000 lb. of steam per hour. Equipped with Foster-Wheeler superheater, economizer, air heater and water walls, the boiler is pulverized-coal

fired by two Aero mills, each supplying one burner, in boiler settings by Frank E. Rees Co. A furnace volume of 8,070 cu.ft. is provided, and maximum heat liberation is about 15,000 B.t.u. per hr. per cu.ft. Both the forced- and induced-draft fans are above the boiler, combustion air being forced down through the air heater, to the air-cooled furnace bottom and then to the windboxes surrounding the burners.

This year a further increase of steam-generating capacity became necessary and two stoker-fired boilers are being equipped with Riley coal pulverizers, burners and a Cash automatic combustion control. One pulverizer on each boiler supplies two burners. These boilers have integral economizers and superheaters, the latter to give a total steam temperature of 450 deg. F. Each boiler has a forced-draft and an induced-draft fan. Air heaters have not been provided and coal is dried in the pulverizers by gas taken from the front of the furnace at a point on a level with the burner centerline. Sufficient gas is used to raise the temperature of the secondary air to 400 deg. F.

Preparing the two old boilers for pulverized-coal firing required that the furnace bottom of each be lowered 11 ft. into the basement. This necessitated excavation of solid ledge by drilling and dynamiting over an area 40x92 ft. All boiler-supporting steel was extended 11 ft. from the old operating floor to the new ash-pit level. It was also necessary to extend three coal-bunker columns 11 ft. to the ash pit, to tie in the new construction. During this change, 200 tons of coal had to be supported in the bunker.

The old boiler settings remained in place and the new work was built up to it. Walls were left supported by some of the ledge which served as piers. These piers were later removed as the new brickwork was tied in with the old. A $\frac{1}{4}$-in. steel-plate smoke flue 120 ft. long having a cross-section of 14 x 11 ft. was also removed. This flue was cut into small sections and lowered 40 ft. by chain fall to a point where it could be removed from the plant. All this work was done by the plant's construction crew and was completed without an off-time accident.

The drawings, Figs. 1 and 2 show the old and the new furnaces. Furnace volume has been increased from approximately 2,400 to 5,300 cu.ft. This volume is sufficient to operate the boilers at 300% normal rating, compared to 175% rating with the old equipment. At maximum rating, estimated efficiency is 82%, but it is expected to exceed this in operation. With the old settings average efficiency was about 72%. Thus 125%

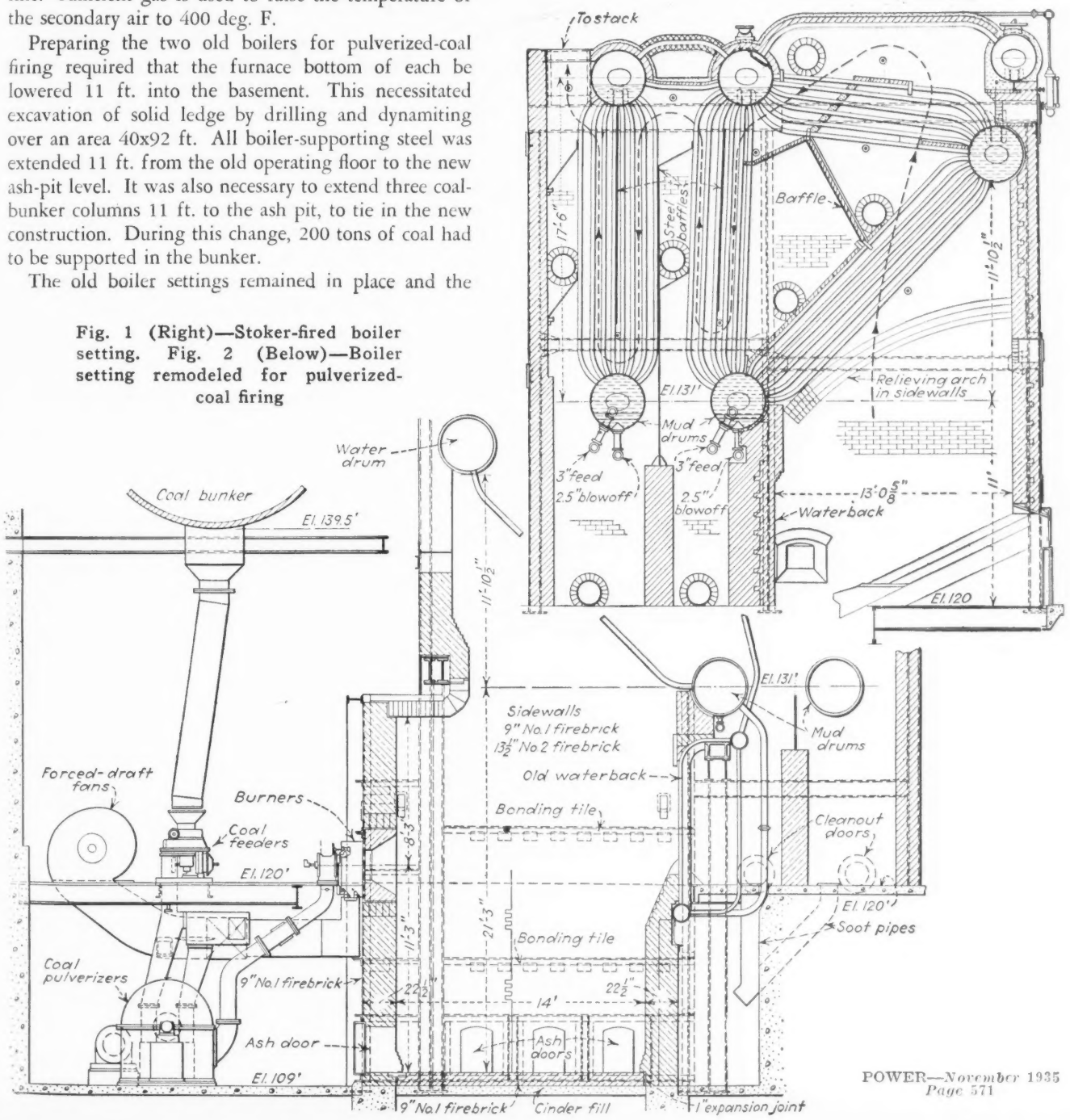


Fig. 1 (Right)—Stoker-fired boiler setting. Fig. 2 (Below)—Boiler setting remodeled for pulverized-coal firing

increase in boiler capacity and over 10% better efficiency is obtained by modernizing the combustion equipment. The first boiler went into service July 1, and the second Sept. 1. Fig. 3 shows the chief steam and power generating equipment now in the plant.

The high-pressure boiler is equipped with meters to permit operation under practically test conditions at all times and is controlled from pushbuttons on the meter panel. An 8-point draft gage indicates furnace draft, right- and left-hand burner pressures in the coal pipes, uptake draft, draft at entrance to air heaters and to induced-draft fan and primary-air pressure at the two burners. This instrument also includes pressure gages for the 110-lb. and 450-lb. steam.

A 6-point recording thermometer records gas temperature in the uptake, leaving the economizer, leaving the air heater, air leaving the air heater, water leaving the economizer and the steam temperature. Other meters on the boiler panel include a CO_2 recorder and a steam-flow air-flow meter. Pushbuttons and signal lights for boiler remote control are also on this panel.

On a panel adjacent to the boiler panel are meters to show feed-water pressures to the 110- and 450-lb. boilers, water level in the deaerating feedwater heater, pressure in this heater, feedwater temperature leaving the heater, and steam temperature in the 110-lb. header.

Pushbutton control of this boiler was selected because of the widely fluctuating load making necessary shutting down the coal feeders at times to keep the safety valve from opening. With only the three paper machines in service it is possible for the paper to break in all three machines at practically the same time, in which case a very large part of the load will be dropped off the boiler. When this occurs the coal feeders must be shut down to keep the steam pressure under control. At the time the feeders are shut down, the ignition torches are lighted off in the furnaces.

When the paper breaks in a machine, it automatically lights a lamp on the boiler control board so that the operator can begin immediately to make the necessary adjustments to control steam pressure. As soon as the paper begins feeding into the machine again the light goes dark and the operator gets the boiler ready to pick up load.

Steam is also supplied to two digesters. Five minutes before a digester is to go into service the boiler operator is given a signal so that the boiler can be made ready for the demand. Steam pressure is brought up on a digester in 15-min. steps, and the operator can, by watching the steam-flow meter, bring the combustion rate up to hold steam pressure practically constant.

This method of operation has proved highly satisfactory. It has produced efficient boiler-plant operation and given the mill operators what they want in steam service. In 1934, yearly average over-all boiler-plant efficiency was 87.4%. In this are included all banking periods and operation of the old boilers. The new boiler has been operated at well over 90% over-all efficiency. Stack temperatures are around 260 deg. F. When the boiler was first installed, stack-gas temperatures were around 220 deg. F., but this was below the dewpoint of the gas and was likely to cause economizer corrosion.

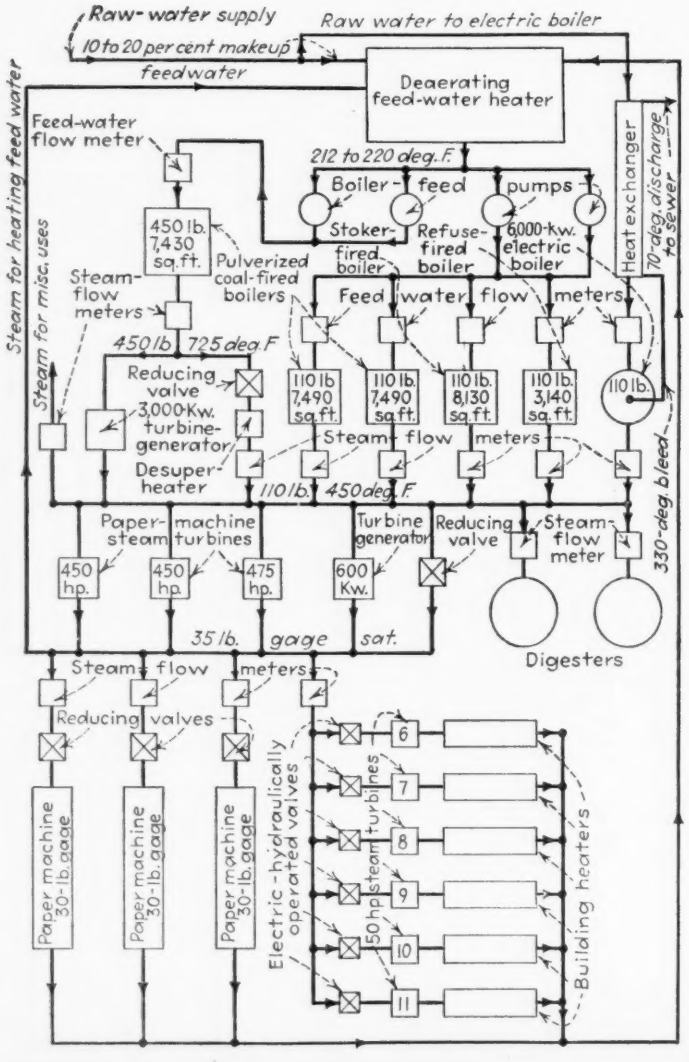
The boiler furnace was designed to operate with combustion conditions to produce 14% CO_2, but 15% CO_2 is being maintained without traces of CO and without objectionable slagging. The fuel burned is a high-grade New River coal having a heat content of 14,600 B.t.u. per lb.

The plant has several other interesting features, including remote operation of the turbines, an automatic system of building heating temperature control and a very complete steam-metering system. All fuel is weighed automatically and steam metered to each use so that a very comprehensive system of records is maintained. These will be the subjects of other articles.

The total savings obtained from this modernization program and intelligent operation are difficult to completely evaluate, but they are very large and have always paid out the investment in at least three to four years. In 1923 the average steam cost for the year was 82.5 cents per 1,000 lb. Today the bogey is 36 cents per 1,000 lb., and the monthly average is below this figure, a reduction of 60%. Comparable savings have been made in production costs and operation has been improved all along the line.

John P. Topolasky, steam engineer, is in charge of all steam equipment in the plant. Modernization of the steam plant, under his personal direction, was done while maintaining 100% service to the production departments.

Fig. 3—Diagram of chief steam and power generating equipment



WHAT IS HEAD ON A PUMP?

Many troubles with pumps are the result of mistakes in estimating head against which they must operate. Here's how these troubles may be avoided

By Frank A. Kristal

Mechanical Engineer,
New York, N. Y.

WHEN planning to install a centrifugal pump, the purchaser is primarily interested in obtaining a unit that will deliver the required quantity of water or other liquid against the necessary head or pressure. These requirements must be transmitted to the pump manufacturer, who will require certain definite data to design the pump properly. In order that there be no misunderstanding between purchaser and manufacturer, it is important that the terms used are the accepted nomenclature of the pump industry. Definitions given here are those used by pump engineers and manufacturers, use of which will simplify any discussion of pump problems.

Fig. 1 is a typical data sheet showing the type of information desired by the pump manufacturer. The first item refers to the kind of service. Since the pump manufacturer has had considerable experience with pump applications, he can make valuable recommendations based on past experience with similar problems. It is also important to know whether the pump is to operate continuously or intermittently. There may be a choice between a high-priced pump of high efficiency, and a pump of lower efficiency at a lower price. For intermittent service, efficiency may not be so important and the purchaser may prefer the lower-priced pump. Depending on the service, the manufacturer may be able to recommend several alternatives operating at different speeds. It is advantageous to the purchaser to have this opportunity of choice so as to be able to make the best selection.

Capacity of Pumps

Capacity—The capacity of a centrifugal pump refers to the quantity of water or other liquid handled in a definite period of time. It is usually stated in gallons per minute, g.p.m. In Canada and the British Empire, capacity is usually given in Imperial gallons per minute. An Imperial gallon is equal to 1.2 times a U. S. gallon. Thus 500 Imperial gallons will equal 600 U. S. gallons.

For larger installations and municipal-waterworks pumps, capacity is frequently stated in million gallons per day, m.g.d. For large irrigation projects, the capacity may be stated in cubic feet per second, c.f.s. Regardless of terms used in specifying pump capacity, the manufacturer will usually convert them to gallons per minute, because all of his design and test data are on this basis. Therefore, it will usually simplify matters to give the capacity directly in gallons per minute. The accepted practice is to regard one m.g.d. equivalent to 700 g.p.m. and one c.f.s. equivalent to 450 g.p.m. (Actually 1 m.g.d. = 694 g.p.m., and 1 c.f.s. = 448.8 g.p.m.)

Head—Since power required to drive a centrifugal pump is a function of its capacity and the head against which it operates, the latter must be accurately determined. A mistake in estimating the head against which the pump will operate may result in obtaining a unit of unsuited characteristics. Total head against which a pump operates comprises several components that include suction and discharge conditions. Figs. 2 to 7 show typical pump-installation diagrams and indicate some of the elements making up total head.

In addition to suction lift or suction head, and discharge head, there must be included head necessary to overcome friction in piping and fittings when the pump is operating at full capacity. Velocity head and entrance and exit losses must also be taken into consideration. These elements are given in the following:

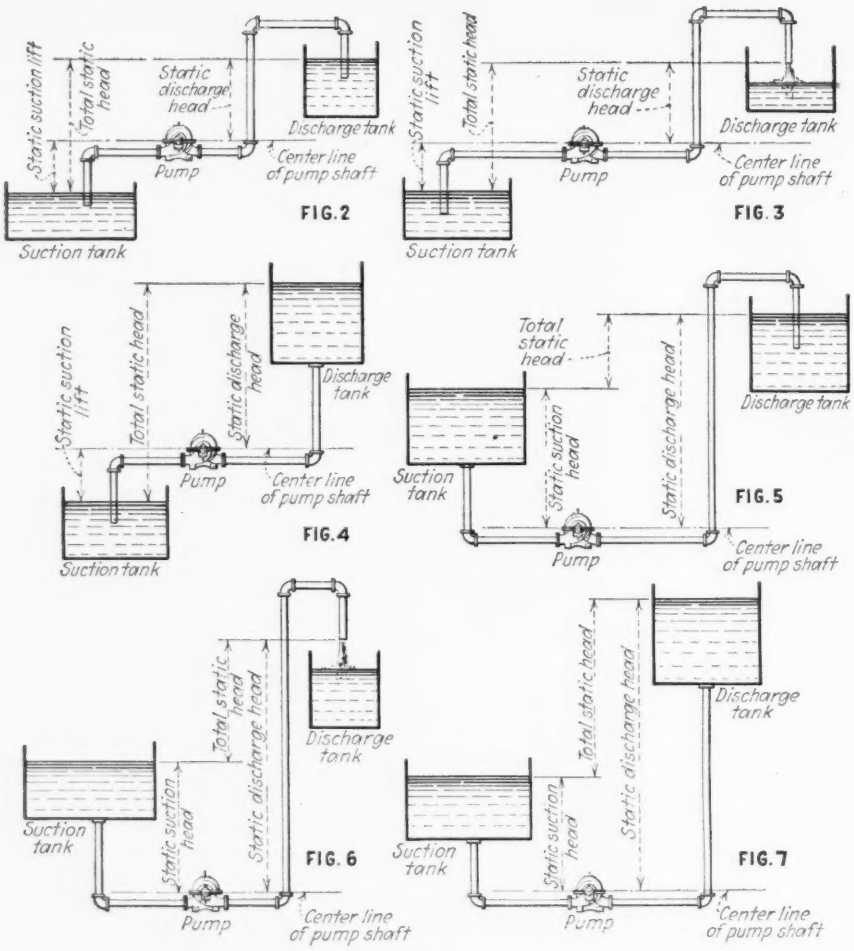
Total Static Head—Vertical distance from free surface of supply source to free surface of liquid in the discharge well, Fig. 2, or to point of free discharge in

Fig. 1—Centrifugal-pump operating-condition data sheet

Data Desired for Estimating Purposes

Pumping conditions vary considerably and it is therefore desirable that this sheet be filled in as fully as possible to insure correct analysis of your inquiry.

1. Kind of Service.....No. of Pumps required.....
   Continuous.....Intermittent.....
2. Capacity,—U. S. GPM.....Kind of Liquid.....
   Temperature ° F.....Specific Gravity.....
3. Static Discharge Head.....Ft. (Vertical distance from center pump to point free discharge)
   Dia. Pipe.....: Length.....: No. Elbows.. 90°: 45°:.....
4. Static Suction Lift .....Ft. (Exists when supply is below center of pump. Vertical distance from center pump down to level source supply)
   Dia. Pipe.....: Length.....: No. Elbows.....90°: .....45°:
   Or Static Suction Head.. ...Ft. (Exists when supply is above center of pump and is vertical distance from center of pump up to level of the source of supply)
   Variation in Suction Lift or Suction Head.....
5. Type of Drive Desired..... Are we to furnish.....
   If Belted.....: HP of Driver..: Speed...: Dia. Driving Pulley..
   If Motor Drive, Direct Current....: or Alternating Current.....
   Voltage...: Cycles.....: Phase.....: Type of Control.....
   If Turbine Drive....: Steam Pressure.....: Superheat.....
   Back Pressure or Inches Vacuum.....:
   If you have driver available, give full rating.....
   .....
   .....
6. Remarks and special conditions not covered above:.....
   .....
   .....



Figs. 2 to 7—Diagrams of typical pump installations

discharge piping, Fig. 3. When both the suction and discharge are under atmospheric pressure, the total static head is merely a difference of elevation.

Static Suction Lift—Static suction lift exists when the source of supply is below the center line of the pump, Figs. 2 to 4, and is the vertical distance from the free surface of the liquid in the suction well or source of supply to the center line of the pump shaft.

Static Suction Head—Static suction head (also known as head on suction) exists when the supply is located above the center line of the pump, Figs. 5 to 7, and is the vertical distance from the pump-shaft center line to the free surface of the liquid in the suction well or source of supply.

Static Discharge Head—The vertical distance from the center line of the pump shaft to the free surface of the liquid in the discharge well, Figs. 2 and 4, or to point of free discharge, Figs. 3 and 6.

Dynamic Suction Lift—Dynamic suction lift exists when the suction measured at the suction nozzle of the pump, corrected to the center line of the pump, is below atmospheric pressure. Where static suction lift exists, dynamic suction lift is the sum of static suction lift and head necessary to overcome friction in the suction line, plus velocity head, plus entrance and velocity losses.

Where static suction head exists but where the sum of friction, velocity and entrance losses exceeds static suction head, dynamic suction lift is the sum of these losses minus static suction head. Thus, a pump may have a suction head when at rest or when operating at partial load, and have a suction lift when pumping its full rated capacity.

Dynamic Suction Head—(Also known as head on suction) consists of static suction head, minus head due to friction in suction line, minus velocity head, minus entrance and velocity losses.

Dynamic Discharge Head—Consists of the static discharge head plus the head necessary to overcome friction in the discharge line, plus the velocity head, plus the exit and velocity losses.

Total Dynamic Head—Consists of sum of the dynamic suction lift plus dynamic discharge head, or, where there is a dynamic suction head, the total dynamic head is dynamic discharge head minus dynamic suction head.

Velocity Head — Velocity head (sometimes called head due to velocity) of water moving with a given velocity is the equivalent head through which it would have to fall to acquire the same velocity, or in other words, the head necessary merely to accelerate the water. If we know the velocity we can figure the velocity head by means of a simple formula.

For any definite capacity we can find the velocity in any pipe line by referring to a set of hydraulic tables, or by using the formula $V = \frac{Q}{A}$, in which Q is the capacity in cu. ft. per sec., A the area of the pipe in sq. ft., and V the velocity in ft. per sec.

Given a capacity of 800 g.p.m. flowing through an 8-in. pipe line, find the velocity. First change capacity from g.p.m. to c.f.s. C.f.s. = g.p.m. $\div$ 450 = 800 $\div$ 450 = 1.78, which is capacity Q. Inside cross-sectional area of the pipe in square feet is $A = 0.7854\left(\frac{D}{12}\right)^2$, where D is diameter of the pipe in inches. Then $A = 0.7854\left(\frac{8 \times 8}{12 \times 12}\right)^2 = 0.35$ sq.ft. In the pipe the velocity $V = \frac{Q}{A} = \frac{1.78}{0.35} = 5.09$ f.p.s.

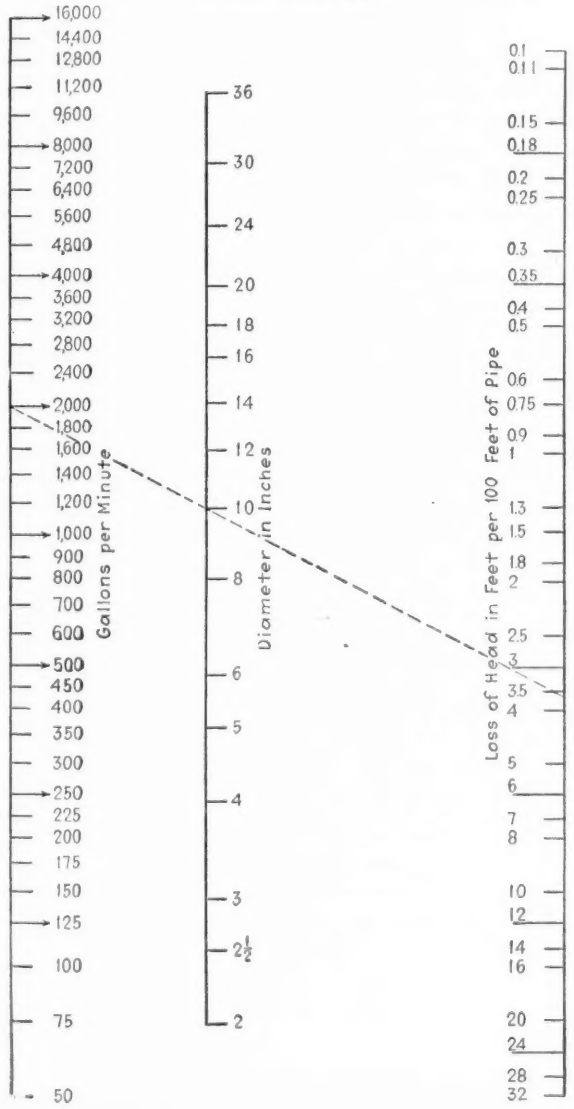
Knowing the velocity in any particular case we can always figure the velocity head from the formula $H = \frac{V^2}{2g}$, in which H is velocity head in feet, V velocity in f.p.s., and g is acceleration due to gravity (32.2 ft. per sec. per sec.). Then $H = \frac{5.09 \times 5.09}{2 \times 32.2} = 0.402$ ft. Table I gives velocity heads for the range of velocities usually occurring in pump practice.

Velocity head is one of the elements making up total dynamic head, but the value is usually so small that it can be disregarded. It should be taken into account when total head is low, and when suction lift is high. This head should also be considered in accurate testing since it is part of the total head and will therefore affect the duty of the pump. When the suction and discharge pipes are of the same diameter, it is only necessary to include in the total head the velocity head generated in the suction piping. In most cases the discharge pipe will be smaller than the suction pipe, then it is necessary to include velocity head developed in the discharge pipe.

Friction Head—Head absorbed in a liquid in motion, among its own particles, and between itself and its bounding surfaces. It is the equivalent head necessary to overcome the friction of the liquid on the interior surface of the pipe and fittings. Friction head varies with the character of liquid being pumped, and condition of piping. Fig. 8 gives a ready means for estimating the loss of head due to friction in various sizes of piping. For example, 2,000 g.p.m. flowing through a 10-in. pipe will cause a loss of head of 3.6 ft. per 100 ft. of pipe, indicated by dotted line.

Specific Gravity—Ratio between the weight of volume of the liquid and the weight of an equivalent volume of water. It is important to know the specific gravity of the liquid to be pumped as it affects the pumping power required.

Fig. 8—Chart for determining the head loss in clean iron pipe



Water Horsepower—W.hp. $= \dfrac{G.P.M. \times H \times S}{3{,}960}$, in which H is total dynamic head in feet and S specific gravity of the liquid. Thus, where a pump is to handle 300 g.p.m. of water against 50 ft. total dynamic head, water horsepower $W.hp. = \dfrac{300 \times 50 \times 1.0}{3{,}690} = 3.8$. If this same pump were handling brine having a specific gravity of 1.2, then water horsepower would be $W.hp. = \dfrac{300 \times 50 \times 1.2}{3{,}690} = 4.56$.

Brake Horsepower—Brake horsepower takes into account the efficiency of the pump. Thus brake horsepower, $Hp. = \dfrac{G.P.M. \times H \times S}{3{,}960 \times Eff.}$. In this case efficiency is expressed as a decimal, that is 60% is used as 0.60, and brake horsepower, in the problem for brine and a pump efficiency 65%, is, $Hp. = \dfrac{300 \times 50 \times 1.2}{3{,}960 \times 0.65} = 7$.

Efficiency—The efficiency of a centrifugal pump, expressed as a percentage, is equal to its water horsepower output divided by the brake horsepower input times 100, thus $(4.56 \div 7) \times 100 = 65\%$.

Viscosity—Refers to the cohesion between particles of any fluid, and is that physical property which causes it to offer a resistance, analogous to friction, to the relative sliding motion of two adjacent particles. This property, chiefly noticeable when the fluid is in motion, is the cause of all so-called fluid friction.

The viscosity of petroleum products is expressed as the number of seconds required for a definite volume of the liquid under an arbitrary head to flow through an orifice of definite size and shape.

Duty—For centrifugal pumps driven by steam turbines, duty is expressed as the number of foot-pounds of work per 1,000 lb. of steam and is equal to the pump efficiency, expressed as a decimal, multiplied by 1,980,000,000, divided by turbine steam consumption in lb. per brake hp. per hr. (Note: Steam consumption of the turbine in lb. per b.hp. per hr. is also known as its water rate and is a measure of turbine efficiency.)

Table I—Relationship Between Velocity and Velocity Head

Velocity ft. per sec.	Velocity Head, ft.	Velocity ft. per sec.	Velocity Head, ft.	Velocity ft. per sec.	Velocity Head, ft.
1	0.02	8	1.00	15	3.49
2	0.06	9	1.25	16	3.97
3	0.14	10	1.55	17	4.49
4	0.25	11	1.87	18	5.03
5	0.39	12	2.24	19	5.61
6	0.56	13	2.62	20	6.21
7	0.76	14	3.04		

For pumps driven by electric motors, the power consumption in kilowatt-hours per 1,000 gal. of water pumped is equal to the total dynamic head in feet multiplied by 0.00315 and divided by the product of the pump efficiency times motor efficiency, expressed in decimals.

A.C. MOTORS

Torques . . . Currents . . . Slip

If you have ever puzzled over alternating-current motor types and applications, don't do it any more. This article gives the right answers

By R. P. Guildford

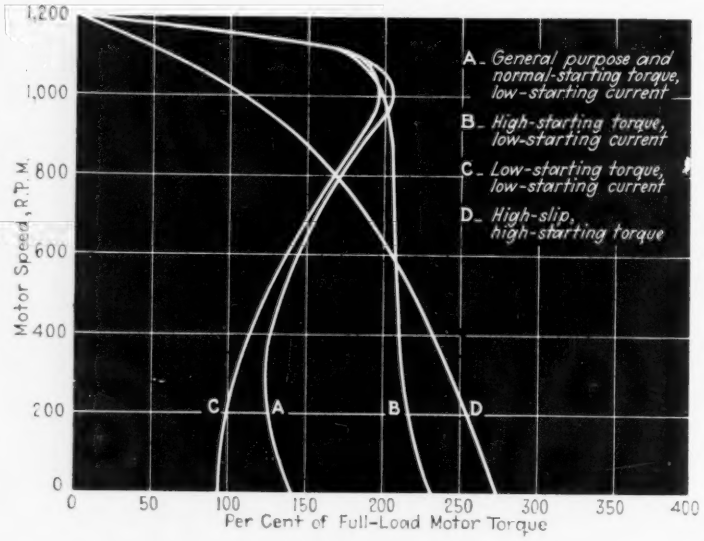
Engineering Division
Westinghouse Electric & Mfg. Company

SINCE full-voltage starting of squirrel-cage induction motors has become accepted practice, various classes of these motors have been developed for different starting requirements of current and torque. Confusion and lack of knowledge on the characteristics of various classes of motors, often results in selecting a motor that is not the best for the particular application.

Some terms classifying these motors and their starting characteristics causing confusion among users are: normal starting-torque, high starting-torque, low starting-torque, high slip, low inrush, high inrush, starting current, locked-rotor current, free-rotor current, etc. The purpose of this article is to clarify the various characteristics involved and various motors used. To make the outline complete, the running characteristics have been considered and synchronous motors have been included. Starting characteristics involved are: starting torque, starting current, accelerating torque and pull-in torque.

Starting torque is actual break-away torque developed at the instant of starting. It is the torque available for breaking away from the static-friction load of the motor itself and the load of the driven equipment. Referring to the curves, starting torque of motor *A* is 140% of full-load running torque.

Speed-torque curves of different types of squirrel-cage induction motors



Two different values of starting current are considered, the locked-rotor and free-rotor currents. At the instant of starting the current inrush is comparatively high, but drops off rapidly as the motor speeds up. The first inrush is the locked-rotor current, that which the motor would take if its rotor could not turn. This current would remain constant and could be read on an ammeter. When the rotor is free to turn, the current changes from the instant voltage is applied until the motor is up to speed. A well-damped ammeter will read less than the maximum inrush, because the current will have started to decrease before the meter needle can swing to a position on the scale corresponding to maximum current. Thus, in making recommendations of maximum permissible starting current Edison Electric Institute has defined this current as the free-rotor current read on a well-damped ammeter, or as 75% of the locked-rotor value.

The E.E.I. recommended values of maximum permissible starting current locked-rotor values are given in Table II. Free-rotor values are 75% of these.

This first locked-rotor inrush of current, taken by a motor, is always the same at a given voltage, regardless of connected load. This is true because the current reaches a maximum before inertia of the rotor has been overcome and it starts to turn.

Accelerating torque should not be confused with starting torque. Accelerating torque depends upon load conditions, whereas starting torque is independent of load. The former is the net torque available for accelerating the driven equipment, and the motor's rotor. It is equal to the torque developed by the motor above that required to drive the actual load as the driven equipment is being brought up to speed.

Pull-in torque of an induction motor is not as important as it is for the synchronous type. It is not always a well defined point of the speed-torque curve, but occurs before the motor reaches its operating speed. The pull-in torque should be considered as the minimum torque point on the curve and this may occur, as is usually the case, at a point midway on the curve. To guard against a design having an objectionably low point in its speed-torque curve, which would result in the motor failing to come up to its full-load slip speed, National Electrical Manufacturers Association has set a minimum standard value of 110% of full-load torque, for all classes of squirrel-cage induction motors.

For synchronous motors, pull-in torque is important. After coming up to its maximum speed, as an induction motor without excitation, it must with excitation

develop a pull-in torque sufficient to pull its rotor and connected load into step at synchronous speed.

The running characteristics of slip and pull-out torque have not suffered from this confusion of terms. Slip is usually given as change in speed from no load to full load, expressed as a percentage of no-load speed. Pull-out torque is the maximum torque the motor will develop before pulling out of step or stalling. N.E.M.A. have set a standard minimum pull-out torque of 200% for all induction motors.

Classes of Motors

Various classes of induction motors according to N.E.M.A. designations are:

A—General-purpose type, normal-starting torque, normal-starting current

B—Line-start type, normal-starting torque, low-starting current (high reactance)

C—Line-start type, high-starting torque, low-starting current (high reactance)

F—Line-start type, low-starting torque, low-starting current (high reactance)

D—High-slip type, high-starting torque, low-starting current (high reactance)

General-purpose, high-speed, synchronous motors.

General-purpose motors have normal starting torque as standardized by N.E.M.A. and given in Table I; normal starting current of the approximate values given in Table III; low full-load slip of around 3 or 4% and a minimum pull-out torque of 200%.

Minimum starting torque for general-purpose motors of various speeds is standardized by N.E.M.A. and is fairly high for 2-, 4- and 6-pole motors. Quite often a motor of this class having around 225% starting torque, is used for an application requiring 150 to 175% starting torque.

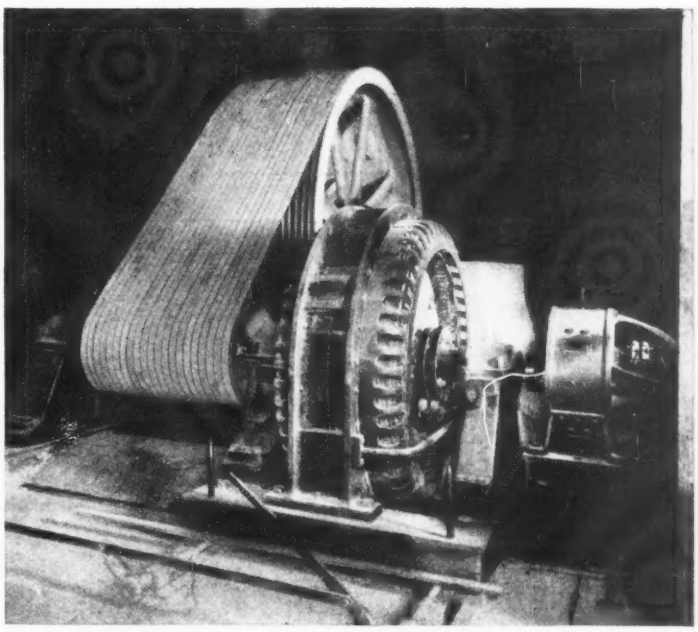
A general-purpose motor will usually handle these applications since in most cases the drive is overmotorized a certain amount, which adds to the already available starting torque of 135 to 150% for the 4- and 6-pole motors. For instance, suppose 175% starting torque is required and 17 hp. actual running power continuous at 1,750 r.p.m. From a power standpoint, a 20-hp. motor is the logical one and since the motor will have 150% starting torque, and is 17.5% oversize it will develop on the basis of 17 hp. a starting torque of 176%.

General-purpose 4-pole motors usually have sufficient starting torque for such applications as plunger pumps, indoor conveyor lines and other applications requiring medium starting torque. Those of lower speeds are suitable for machine tools, lineshaft drives, centrifugal pumps, fans, unloaded compressors, and similar loads. Curve *A* is a typical speed-torque curve.

Normal-starting-torque, low-starting-current motors have normal starting torque as standardized by N.E.M.A. Table I; low starting current within the E.E.I. recommendations, Table II, up to 30 hp.; low full-load slip of around 3 or 4%, and a minimum pull-out torque of 200%. Above 30 hp. they have a starting current within the E.E.I. recommendations when started with an auto-transformer type of starter. When started on full voltage, the starting current is around 500 to 600%. These motors are suitable for the same applications and have the same minimum starting torque as general-purpose motors. They are used when the starting current must be limited to the E.E.I. values and have a typical speed-torque curve similar to curve *A*.

High-starting-torque, low-starting-current motors have high starting torques of approximately 225% for all common speeds. Starting current, full-load slip and pull-out torque are the same as the normal-starting-torque, low-starting-current motors, just described. These motors are used for applications requiring high starting or break-away torque, such as loaded compressors, plunger pumps if motor is low speed, outdoor conveyors, presses and rolls without flywheels.

Although they usually have a greater accelerating torque than the class *A* and *B* motors, they should not be used for machines using flywheels, such as presses, punches and shears requiring high accelerating torque. This is because they have a low-full-load slip of around 3 or 4%. A flywheel application requires a motor having around 10 to 12% slip, which will slow down under peak loads. Curve *B* is a typical speed-torque characteristic of this type motor.



250-hp. synchronous motor driving 6 rotary cone crushers through V-belt to lineshaft

Low-starting-torque, low-starting-current motors have starting torques between 40 to 70%; starting currents within the E.E.I. recommendations, when started on full voltage; low full-load slip of 3 or 4% and a pull-out torque of approximately 150 to 175%. They are used where 40 or more hp. is required, but where full-voltage starting is desired with the starting currents less than E.E.I. recommendations. Starting current is kept low at the expense of starting torque. These motors find a wide use for low-starting-torque applications, such as centrifugal fans, centrifugal pumps and motor-generator sets, especially in public buildings where starting current must be kept at a

minimum. Curve *C* is a typical speed-torque curve of such motors.

High-slip, high-starting-torque, low-starting-current motors have starting torques of about 275%; low starting current within E.E.I. recommendations up to 30 hp. and 500 to 600% starting current in larger sizes. They have a full-load slip of 8 to 10%. Their pull-out torque is equal to the starting torque, Curve *D*. As increasing values of overload are applied the motors will gradually slow down until finally stalled.

They are used for driving punch presses, shears and other machines equipped with flywheels. Their high starting and accelerating torque allow them to start and accelerate high-inertia loads and their high full-load slip permits them to slow down under peak loads, sufficiently for flywheel applications.

Synchronous Motors

General-purpose high-speed synchronous motors have starting torques of approximately 115% for 100% power factor and 140% for 80% power factor; and full-voltage starting currents of around 400 to 500%. This starting current can in many cases be kept within E.E.I. recommendations. Pull-in torques are 100% or over for both 100% power-factor and 80% power-factor motors. Pull-out torques are approximately 170% for 100% power-factor and 215% for 80% power-factor motors.

Synchronous motors have come into use rapidly for general-purpose industrial drives. They are very often used in sizes greater than that actually required for the mechanical drive, in order to correct power factor. In sizes above 25 hp. they are the lowest cost and most economical form of power-factor correction, when also required as a mechanical drive. They are suitable for the hardest type of service. The standard general-purpose type will handle most applications and where necessary, their characteristics can be made to meet almost any conditions. The photo shows a 250-hp. general-purpose synchronous motor driving secondary-cone-type rock crushers through a multiple V-belt.

The approximate characteristics of these classes of induction and synchronous motors are grouped in Table IV. Values of torque and current are given in per cent of full-load values at full voltage. Note that all values of starting current given in the discussion, and the table are based on locked-rotor values.

Slip-ring, wound-rotor induction motors have not been included in the discussion since they have not become involved in the confusion of terms as applied to squirrel-cage motors. However, to make for quick-reference they have been included in Table IV. It is an easy matter to limit the starting current of these motors and still obtain any practical starting torque, by using the proper secondary resistors. When running at full speed with their rings short circuited, they follow the characteristics of curve *A*.

Table I—N.E.M.A. Standard Minimum Starting Torque at Full Voltage for General-Purpose Induction Motors

No. of Poles	Full-Load Torque, %	No. of Poles	Full-Load Torque, %	No. of Poles	Full-Load Torque, %	No. of Poles	Full-Load Torque, %
2	150	6	135	10	120	14	110
4	150	8	125	12	115	16	105

Table II—Starting Current in Amperes Recommended by E.E.I. for 220-volt Squirrel-Cage Induction Motors; Locked-Rotor Values†

Hp.	3-Phase	2-Phase	Hp.	3-Phase	2-Phase
3	60	53.4	25	304	270
5	86.5	74.5	30	360	320
7.5	115	98.6	40	380	334
10	141	123	50	400	345
15	197	171	*	8.0	9.0
20	251	222			

*Amperes per horsepower, 60 hp. and above.
†Current for or of other voltages is inversely in proportion.

Table III—Approximate Starting Current at Full Voltage for General-Purpose Squirrel-Cage Induction Motors; Locked Rotor Values

No. of Poles	Full-Load Amperes, %	No. of Poles	Full-Load Amperes, %	No. of Poles	Full-Load Amperes, %
4	850	8	650	12	450
6	750	10	550		

Table IV—Approximate Characteristics of Induction and Synchronous Motors

Type	Starting Torque, %	Starting Current %	Minimum Pull-In Torque, %	Minimum Pull-Out Torque, %	% Slip
General Purpose *A*	Normal, Table I	Normal, Table III	110	200	3 to 4
Line-start *B*	Normal, Table I	E.E.I. Table II	110	200	3 to 4
Line-start *C*	220	†E.E.I. Table II	110	200	3 to 4
Line-start *F*	40 to 70	Table II	40 to 50	150 to 170	3 to 4
High Slip *D*	275	Table II	...	200	8 to 10
Synchronous, 100% Power Factor	115	**550	100	170	
Synchronous 80% Power Factor	140	**450	100	215	
Wound Rotor	100 150 200	100 150 200	110	200	3 to 4

*Within E.E.I. recommendations up to 30 hp.; 40 hp. and larger within E.E.I. recommendations using auto-starter and 500 to 600% on full-voltage starting.
**Can in many cases be kept within E.E.I. recommendations.

Typical Boiler Defects

IN THE Second Quarter (1935) Progress Report of the Bureau of Engineering, State of Wisconsin, are some interesting figures on boiler inspections by the Industrial Commission Division, headed by R. McA. Keown, engineer.

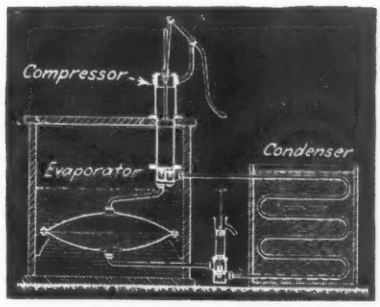
In addition to the 4,691 boilers inspected by insurance and railroad companies, the division conducted 217 internal boiler inspections and 249 external. Boiler defects noted by the Industrial Commission inspectors were listed as follows:

Pitting or corrosion	47
Oil or scale	65
Leakage	24
Defective setting	8
Fire cracks	6
Bulged sheets	9
Defective tubes	28
Insufficient openings for cleaning and inspection	4
Fusible plug—misplaced or defective	6
Water glass—low or defective	9
Safety valve—defective or improperly installed	46
Steam gage—missing or defective	5
No pump or injector	9
Defective return pipes	6
Defective water column or connections	34
Gage cocks—missing or defective	20
Blow-off pipe—missing or defective	61
Improper feeds lines	17
Excessive pressure carried	11
Miscellaneous	25
Total	430

DRYING METHYL CHLORIDE

A *Power* reader has asked how to dry methyl chloride. Our inquiry to the manufacturers brought this detailed reply

By E. W. McGovern
E. I. duPont deNemours & Co.



Perkins' original refrigerating machine of 100 years ago

THE primary reason for removing water from a refrigeration system charged with methyl chloride is that such quantities of water as may be present above a few hundredths of a per cent will tend to separate as ice at the expansion valve and thus affect proper functioning of the machine. Larger quantities of water may even freeze up the refrigerant lines. This tendency for water to cause trouble by freezing generally necessitates its removal before a further possible consequence of its presence, corrosion, becomes important.

Methyl chloride in itself is neither acid or corrosive and is manufactured to a specification of 0.001% or less by weight of acid calculated as hydrochloric acid. Also, under ordinary conditions it will not form acid when in contact with water. Because of this methyl chloride is essentially non-corrosive to the common engineering metals under ordinary conditions. Zinc, aluminum, die castings may be classed as exceptions since in the presence of even small amounts of water some corrosion of these metals may take place. However, in addition to water itself being corrosive, if methyl chloride and water are in contact over a long period of time at higher temperatures often existing in refrigerating compressors, they may form small amounts of acid and therefore cause corrosion of other metals.

Although methyl chloride as purchased is of very low water content, being manufactured to a specification of 0.01% or less by weight of water, in service practice it is advisable to dry a system after charging because of moisture that may be introduced in the charging process, moisture in the lubricant, or moisture already present in the machine.

A fair job of drying may be obtained by flushing with methyl alcohol (methanol) and then blowing out with *dry* air, but it is best that even this be followed by chemical drying, after refrigerant has been charged. If air is not available, it is sometimes the practice to blow out the system with a little methyl-chloride gas.

In general service practice, chemical drying is sufficient unless very large quantities of water are present in a system, in which case the methyl-alcohol flushing above described should be used.

Whatever drying agent is employed, it is important that it be used in connection with an efficient filter such as felt or mineral wool, so as to prevent passage of finely divided or disintegrated material into the refrigeration system. Also, the drying agent should be in the form of coarse granules.

It is not practicable to reactivate any of the drying agents that are used in refrigeration systems. Ordinarily, activated alumina and silica gel can be reactivated easily by heating, but in refrigeration work contamination by oil makes this impractical.

Anhydrous calcium chloride has been widely used as a drying agent for methyl-chloride systems, but with varying success. While there is no objection to it from the standpoint of drying efficiency when properly used, its use is not recommended because of its tendency to induce corrosion in the refrigeration system, especially at the expansion valve. The sources of practically all cases of corrosion in methyl-chloride systems have been traced to the use of calcium chloride in the presence of moisture. In spite of the foregoing facts, calcium chloride often has been and is being used without trouble for drying methyl-chloride systems, but its use must be attended with special care. It should not be permitted to absorb more water than would form the monohydrate—an amount equal to 16.2% by weight of the calcium-chloride charge. Also, a calcium-chloride dehydrator should not be left in the system for more than a few days. One cannot expect acid to be removed from a refrigeration system by the use of calcium chloride, since only a small and insufficient amount of alkali is present in the commercial grade generally used.

Calcium Oxide

Calcium oxide is a satisfactory drying agent for methyl-chloride systems. It will not cause corrosion and as a matter of fact it may prevent corrosion by virtue of its ability to neutralize acid that may be in the system. Its maximum water-absorbing capacity is 32.1% of its own weight, but it should not be depended upon to take up more than about half of this because of the desirability of being on the safe side and keeping the dryer in an efficient condition as well as its tendency to disintegrate to a fine powder on taking up water. This latter tendency is its only disadvantage, as the fine powder may pass into the refrigeration system unless an efficient filter is used. When stored prior to using, calcium oxide should be kept in

air-tight cans, not only because it absorbs moisture from the air, but also because of its tendency to absorb carbon dioxide from the air to form calcium carbonate which has no drying properties.

Soda lime, which is a mixture of calcium oxide and caustic soda, also has been reported as very satisfactory for drying methyl chloride. It both absorbs water and neutralizes acid and probably has much less tendency to disintegrate than does straight calcium oxide.

Activated alumina, which is a special form of aluminum oxide, is a satisfactory drying agent for methyl-chloride systems, but its moisture-absorbing capacity is more limited than that of the above substances so that comparatively larger quantities must be used. While its tendency to disintegrate to a fine dust is not as great as that of calcium oxide, nevertheless, as with all chemical drying agents, trouble may result if it is not used in conjunction with suitable filters. It will not in itself induce corrosion, but its efficiency in removing acid is unknown. It is more expensive than the commoner drying agents.

Neither magnesium perchlorate nor barium perchlorate should be used for drying methyl-chloride refrigeration systems as they may be the cause of dangerous explosions when employed for this purpose.

Methyl alcohol is also used as an anti-freeze in methyl-chloride systems. Because methyl alcohol does not remove the water but leaves it in the system where it may be a source of corrosion, its use is recommended only as a temporary measure for opening up systems which may be partly but not completely frozen up. 2½% methyl alcohol in methyl chloride is recommended.

Various other drying agents have been suggested for methyl chloride, but there is not enough data available concerning them to enable us to unqualifiedly recommend any of them. Among these are the following:

Barium oxide should have all the advantages of calcium oxide, to which it is chemically similar, but it is probably more expensive and, at least at present, not as universally available. It probably removes water more rapidly and more thoroughly than does calcium oxide. While it may have other advantages, they are not readily apparent.

Anhydrous calcium sulphate probably would be satisfactory from a drying standpoint, but it would not neutralize acid. A combination of anhydrous calcium sulphate and a small amount of calcium oxide would probably prove satisfactory.

Silica Gel

Silica gel is of a type similar to activated alumina. While it undoubtedly has good drying properties it is comparatively expensive and is not alkaline, so that acid removal depends on absorption with water, this being of unknown efficiency.

Caustic soda and caustic potash would dry and neutralize methyl-chloride systems, but they probably would be unsatisfactory in refrigeration practice because of difficulty in handling and their tendency to quickly form water solutions.

CONDITIONED AIR; NO DRAFTS

Poor air distribution is the cause of much discomfort in air-conditioned rooms. Here are factors to be watched and methods of distribution that have proved successful

By R. B. Purdy

Associate Editor

THE job of air conditioning does not end with the cooling, dehumidifying and filtering of the supply air for it must be brought to and distributed evenly in the space that is to be conditioned. Faulty distribution has often ruined what would otherwise have been an excellent air conditioning system. Hence considerable care should be taken in laying out the duct system and method of distribution.

Most important in distribution is to avoid all drafts. Remember that in summer the supply is colder than the rest of the air in the room. A relatively slight movement of this cooler air striking the head, back of the neck or shoulders will cause discomfort and complaint. Nowhere in the occupied zone should there be an air movement of more than 2 ft. per sec.

Even distribution is next in importance. There should be no noticeable warm spots or cool zones. This does not necessarily mean that the temperature must be the same at the ceiling and floor, but in the 7 ft. occupied zone the temperature should be as even as possible and not vary suddenly.

Thirdly the duct system should be designed and proportioned so as to avoid both transmission of noise and production of noise. Of course, not as much care need be taken to prevent noise when a factory is being air conditioned as in the case of an auditorium or office building. Usually objectionable noise can be prevented by limiting the air velocity, bracing the ducts so that pressure fluctuation will not cause vibration of the duct walls and by using canvas connections at the fan inlet and outlet. Very low noise levels can be obtained when necessary by lining the ducts with sound absorbing material.

Duct systems for air conditioning do not differ from those required for ordinary ventilation. They should be run in the shortest and most direct way possible, avoiding all unnecessary bends or turns to keep friction losses at a minimum. When bends are necessary use a radius of not less than 1 to 1½ diameters or install directing vanes. Or better still use a bend with square

outer corner and curved inner corner when followed by straight duct. The friction loss is reduced by 10% and by 78% if properly designed vanes are used.[1] Changes in cross-sectional area should be gradual. Allowable velocities are about as follows:

	Ft. per min.
Main supply ducts in public buildings	1200 to 1600
" " " infactories	2500 to 3000
" " " in departmen stories, etc	2000 to 2200
Branch ducts	600 to 1000
Vertical flues	400 to 800

It is advisable to install dampers in all branch ducts leading to supply grilles so that the volume of air discharged may be adjusted to the design value. Such dampers should be provided with means for locking them in position.

In deciding upon the location of conditioned air inlets and the type of registers used it must be recognized at the outset that in the summer the conditioned air is cooler than the air in the room and hence denser. Being heavier it will thus tend to remain at the floor level if introduced into the room at the floor not mixing with the room air unless some positive means is provided to force an upward movement. A layer of cool air at the floor will be uncomfortable to most people. Likewise if the cool air is introduced at the ceiling it will tend to fall through the warm air without mixing unless a turbulent condition is created. Streams of falling cold air will also create discomfort. Of these two conditions the second is easiest to overcome and hence in most central air conditioning systems air is introduced at or near the ceiling creating a general downward air movement.

To prevent lanes of falling cool air when ceiling supply outlets are used arrangements such as shown in Fig. 2 are used. The incoming air is made to strike a flat plate or defuser that spreads the air out horizontally in all directions. Such registers take many forms to fit the room decoration and sometimes are used for lighting fixtures. Some times the exhaust inlets are placed at the center of these plates with satisfactory results where ceilings are not too high. Successful installations of this type have been made with entering air temperatures as much as 15 deg. below normal room temperature at the 4 ft. level.

Ceiling outlets usually require furring to hide the air ducts. When this is not desirable air may be supplied horizontally through wall outlets placed near the ceiling. When the system is designed so that the temperature difference between supply air and room temperature is low the velocity of air through the outlet register may also be low, about 300 ft. per min. To secure low velocity it is not sufficient to make an abrupt enlargement at the register as the air will maintain the duct velocity at the center portion of the register. The duct should gradually enlarge some distance back of the register.

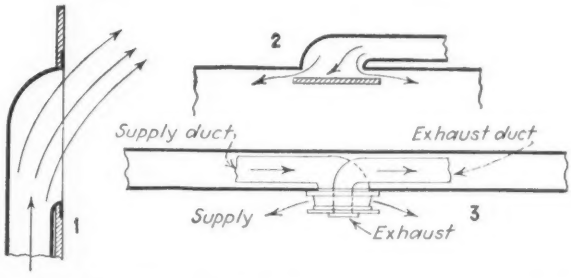
When the temperature difference between entering air and room is large it is necessary to insure mixing with room air. This may be done by using high velocity and designing the outlet so as to obtain an aspirating effect. With this arrangement the issuing stream of air entrains air from the room which quickly raises its temperature. Secondary circulation is set up causing considerable air movement and the high velocity carries the air a considerable distance into the room before it falls. Unless special grilles with directing vanes are used the jet of supply air will not be perpendicular to the face of the grille but at some angle as indicated in Fig. 1.

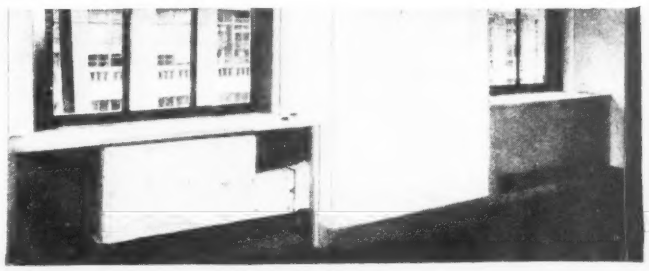
Recently in office building air conditioning supply outlets have been placed along the windows and made a part of the radiator enclosure as in Fig. 4. These outlets discharge upward at a slight angle, usually not more than 30 deg. to the vertical and at high velocity. The same principle of entrained air is involved as in the case of horizontal high velocity supply just mentioned. With this arrangement exhaust inlets are usually placed near the floor at the inside wall. When the space is open only one exhaust inlet may be necessary as in the case of a recent office building where exhaust was placed in the elevator corridor on each floor.

Most unit conditioners are arranged for floor mounting with supply discharged from the top with sufficient horizontal velocity to carry the air well into the room. Return air to the unit which is usually along the floor should be at low velocity. Location of these units is influenced by many local conditions such as space availability, convenience of making piping and electrical connections, as well as position of occupants and equipment in the space to be conditioned. But in satisfying these factors the unit must not be placed so it will not cause draft. When possible and providing they will not interfere with direct radiation already occupying the space it is well to place unit air conditioners under windows.

When planning the distribution of conditioned air attention should be given to location of doorways, sources of heat and infiltrations through leaky windows as they have a marked effect on air flow and even temperature conditions.

Methods of supplying conditioned air: 1—To obtain horizontal supply, diverting vanes are often necessary. 2 and 3—Ceiling supply outlets should be provided with means for distributing flow horizontally. 4 (photograph)—Example of vertical supply at windows in front of direct radiation





[1] Tests by Loring Wirt reported General Electric Review, June 1927.

TOWBOAT LICKS CYLINDER OIL

Condensate, with 30 p.p.m. of emulsified oil, passed on plenty of trouble to boilers until it was cured by ferric sulphate

REMOVAL of free and emulsified oil from condensed steam has always been a nightmare to power engineers. The best of systems go awry at times, and then the troubles start. The presence of oil in boilers means bagged sheets, blistered tubes, foaming and priming and plenty of worry all around.

Condensate is usually pure distilled water, and ordinarily the only contamination is oil from the cylinders and rods of reciprocating units. The oil may be present in the form of free drops or as an emulsion. Each form requires different treatment. Free oil can usually be removed by separators, grease extractors, skimming tanks or some other method of mechanical separation. The oil-in-water emulsion presents a different and more difficult problem. A possible solution is the substitution of raw water for the condensate, but this is a last resort, for the savings to be made by using the condensed steam are considerable. There is the gain of the heat of the condensate, as against the heat used to bring raw water up to condensate temperatures. Losses due to scaling of piping and boilers from raw water result in lower efficiencies and increased outage tor cleaning, and the increased cost of treatment of the fresh water in the boiler is frequently increased by the high cost of water in some localities. Coagulation with alum, followed by filtration, is practiced, but in our experience this is not capable of close control.

A Simple Solution

The following solution of an oil-removal problem in a towboat plant may be of assistance to others facing the same trouble, either on land or water. Briefly, it was found that a clean water could be obtained from a condensate containing 30 parts per million (p.p.m.) of emulsified oil, by coagulation with ferric sulphate and filtration. The process is simple and cheap. Results are excellent.

The towboat "Tennessee" is steam driven, with watertube boilers operating at 260 lb. pressure and a total temperature of 610 deg. F. The two boilers are cross-drum, straight-tube, with a total of 4,536 sq.ft. heating surface and 454 sq.ft. of superheaters of the interdeck type. The two main engines are 3-cyl. vertical uniflow of 1,000 hp., each, exhausting into a single-pass surface condenser of 1,250 sq.ft. at 26 in. vacuum. Lubrication for the cylinders is a straight mineral oil without compounding.

The particular characteristics of this installation cause the cylinder oil to become emulsified in the condensate. This emulsion, if fed into the boilers, causes considerable damage. Oil content of the condensate is 30 to 32 p.p.m., or about 90% of the cylinder oil fed. The remaining 10%, not emulsified, rises to the top of the open hotwell and is skimmed off, or is caught in sponges.

The condensate has in the past been coagulated by solutions of alum and of soda ash fed separately into the second compartment of a 4-compartment open hotwell. Capacity of this well at maximum load is 17 minutes, and for the last three compartments after the coagulating chemicals are added is 13 minutes. The compartments have a 24-in. layer of loofah sponges packed midway in the vertical height between wide-mesh smoke-stack screening. Oil not emulsified catches in these sponges (which are cleaned monthly) or floats on top of the water, where it is skimmed off every 6 hr. with a dustpan-type skimmer.

Flow in this hotwell is down through each large compartment with a narrow upflow channel between each. From the hotwell, water is pumped through two conical-type sand filters operated in parallel. These have fine sand at the top, graduating through fine gravel to coarse gravel at the bottom. Each filter is backwashed in turn, the other carrying the full load during the backwash period. Operation prior to the work described here has been only partially satisfactory. Boilers have been operated for 4 months without cleaning. When opened, a gummy sludge is found characteristically in small balls and particles in the steam drum and in the bottom of the vertical headers. Tubes showed a dusty deposit that could be rubbed off. The steam drum showed an oily film above the water line where the oil had obviously been steam-distilled. No scale was present.

Boiler Treatment

Boilers are treated properly to maintain a high alkalinity of 20 to 30 g.p.g., 30 p.p.m. of phosphate and 1,000 to 17,000 p.p.m. of sulphate. The effect of this balance is to prevent scale and maintain the oil in a sludge. Boiler blowdowns are customarily four surface and one bottom blowdown each 24 hr.

The floc formed when using aluminum sulphate was light and feathery. In order to increase the weight and stability of the floc, magnesium sulphate was used with very slightly better results in size of floc and no betterment in stability under agitation. Trisodium phosphate was added with the soda ash without noticeable change in results.

Furthermore, difficulty was encountered in the formation of the alum floc on account of the small pH range through which it was effective and the accurate and close balance of alum and soda-ash feed required. While feed of the solutions was metered by small close-clearance plunger pumps mounted on and driven by the hotwell pump, a variation of plant load caused

IN BOILERS

By A. C. Stutson

Supervising Engineer,
Mississippi Valley Barge Line Co.

the floc to disappear. The most effective floc was formed at a pH of 6.8. This caused corrosion in the piping. Carryover of alumina into the boilers was sometimes quite high. The water cleared up slowly after a filter backwash. While the aluminum sulphate was partially effective, nevertheless some better coagulant must be found. Ferrous sulphate and ferric chloride and sodium aluminate were not successful. It was not until ferric sulphate became available that such a proper agent seemed possible.

Samples of the condensate were taken from the boat, and a check was made in the laboratory of the results of coagulation with ferric sulphate as compared with alum. These tests indicated a wide pH range of effectiveness for the ferric sulphate. The floc was heavy and stable. Best results were secured with both alum and ferric sulphate when the water was at 135 deg. F., the actual operating temperature. As a result of this preliminary work, arrangements were made to try out the ferric sulphate under actual operating conditions.

The ferric sulphate used was a commercial anhydrous grade containing 92% soluble anhydrous ferric sulphate. Inasmuch as ferric sulphate solutions are quite corrosive to ordinary metals, a new metering pump of stainless (18-8) steel was made and temporary rubber hose supplied to feed the solution during the test.

The water cycle is shown in the line diagram. Condensate enters the open hotwell at 127 deg. F., but the drain trap discharges into the same compartment and raises this to between 138 and 145 deg. F. Drop in temperature through the filters is not over one degree.

Test samples were taken from the No. 1 compartment of the hotwell and from the outlets of the two sand filters. An observation tube on the outlet side of the filters gave a clear view of the water at all times.

Operating conditions were fairly constant during the entire time of the test. There were three periods of low load totaling 18 hr. of the 160 hr. of the run, otherwise load was constant. Average steam flow per day was 620,000 lb., or 25,833 lb. per hr.

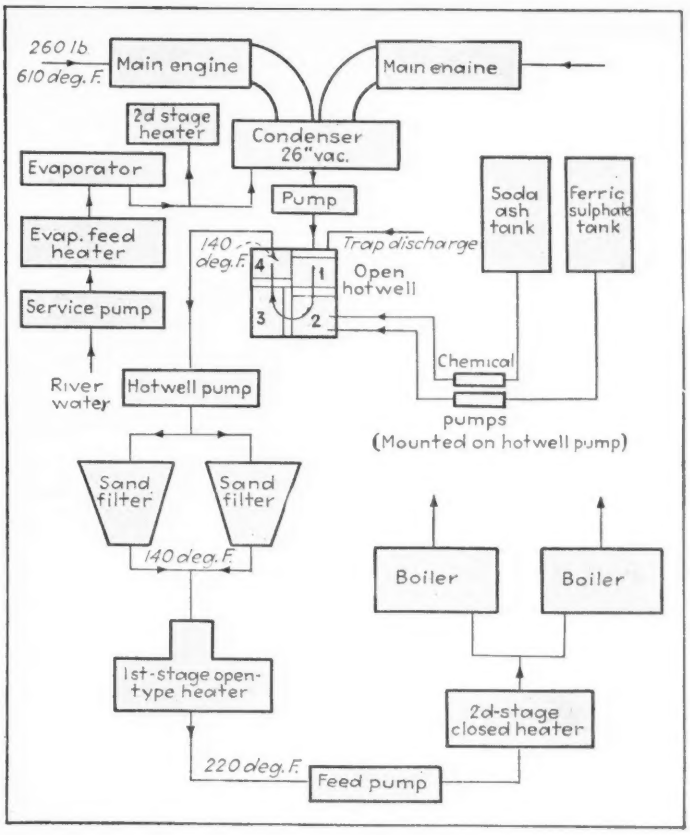
Each sand filter was backwashed twice every 24 hr. with evaporated water, and filtered to waste until clear.

Total steam flow was:

June 16	565,000 lb.
June 17	632,000 lb.
June 18	604,000 lb.
June 19	698,000 lb.
June 20	601,000 lb.

Operation is 24 hr. per day.

Samples of condensate were taken from the first compartment of the open hotwell, and the amount of oil read by an oil turbidimeter. A composite of samples showed 30 p.p.m. of oil present. From this composite, a series of standards were prepared, beginning with carefully filtered and distilled water for the 0.00 p.p.m. reading. All turbidity readings were then made by comparison of samples with the standards in a turbidimeter.



Water cycle of Str. "Tennessee"

The pH values were made by a potentiometer, and during the first part of the test also by a color comparator block. Color standards for the lower ranges had faded, consequently all readings were later made by potentiometer only.

The first day of the tests, the chemical feeds per gallon of water treated were set at 0.15 g.p.g. of alum and 0.075 g.p.g. of soda ash. Turbidities of filter effluent ranged from 12.00 p.p.m. down to 0.04 p.p.m., but were mostly consistent around 0.25 p.p.m. The pH range was from 7.15 to 6.4, with the lowest turbidity at 6.8 and 6.9. The pH of the condensate into the open hotwell stayed around 6.6. CO_2 in the filter effluent was from 0.8 to 1.3 p.p.m.

On the second day, feeds were raised to 0.30 g.p.g. of alum and 0.15 g.p.g. of soda ash. Turbidities went from 0.04 p.p.m. on the first test to 2.00 p.p.m. and varied again as low as 0.25 p.p.m. The pH increased to a range of 7.1 to 7.5, where it remained, dropping on two tests to 6.3 and 6.7. CO_2 varied between 0.9 and 2.1 p.p.m.

Appearance of the water samples at turbidities up to 0.25 was clear to the eye until placed in comparison with the standards, when the cloudiness became easily apparent.

On the third day, the chemical solution tanks were

drained and cleaned. The ferric sulphate was dissolved in a 3-gal. stone crock in 6-lb. lots by adding 1 gal. of clean hot water and stirring until the color turned a rich chocolate brown. This solution was then poured into the rubber-lined feed tank and clean water added to bring the feed to the proper concentration. Feeds of 0.3 g.p.g. of ferric sulphate and 0.1 g.p.g. of soda ash were set. Turbidities immediately fell to 0.02 p.p.m. and most samples to 0.00 p.p.m. The pH started out at 6.7 and gradually fell to 5.8. Variations of pH after the first 6 hr. were between 5.5 and 5.8. CO_2 was around 1.7. At the end of 20 hr. turbidities remained at 0.00. During this time the filters were backwashed twice.

It was decided to reduce the soda-ash feed gradually to discover the lowest pH for effective coagulation. This was done in three steps, during which the turbidity remained at 0.00 and pH fell from 6.5 to 5.6, where it remained after the soda-ash feed had been shut off. Ferric-sulphate feed remained the same. Soda-ash feed was then increased in steps to 1.17 g.p.g. The turbidimeter showed 0.02 at 8.7 pH increasing to 1.00 at 9.0 pH. This was evidently the upper range of effectiveness.

Feeds were then placed at 0.3 g.p.g. of ferric sulphate and 0.78 g.p.g. of soda ash. Turbidities were consistently 0.00 and pH 8.0.

Several samples showed a turbidity of 0.02, and this was at first thought to be caused by improper handling of the filters in backwashing. A careful watching and a series of samples drawn did not bear this out, however, and it is probable that until the entire system is thoroughly clear, some such deviation may occur.

Conclusions

The use of ferric sulphate for flocculation of 30 p.p.m. of mineral oil from an oil-in-water emulsion was entirely satisfactory through a pH range of 5.5 to 8.6. Use of aluminum sulphate under the same conditions was only partially effective through a pH range of 6.7 to 6.8.

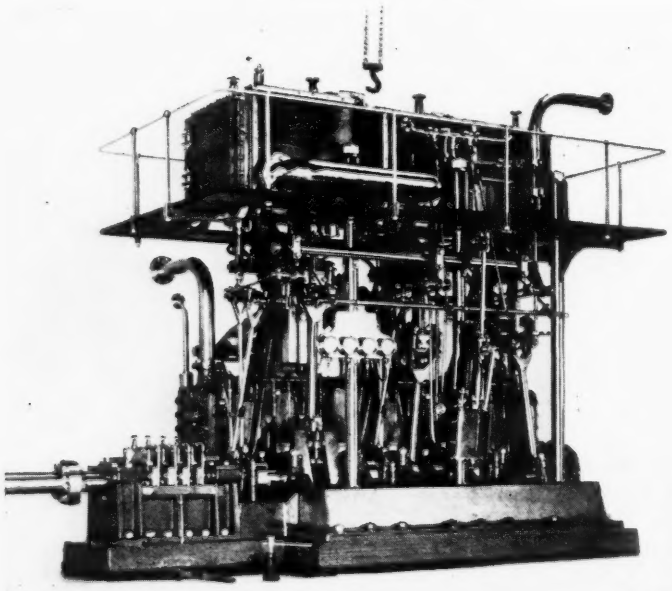
Inspection of the boilers after a 2-week period of operation on ferric sulphate showed considerably less oily sludge present than was formerly found, although no time had been available for cleaning the boilers or system of the oil already present before using ferric sulphate.

EIGHT HUNDRED PONYPOWER

FOR the past five years, Fred D. Hood of Los Angeles has been putting in his spare time building an 800-hp., 17 x 27 x 44 x 30-in., triple-expansion, condensing type marine engine, operating on 180 lb. pressure at 120 r.p.m. That's a pretty big job, so Mr. Hood has made it in miniature, building to a scale of 1 in. per ft. His engine is 17¼ in. high from bottom of bed to top of relief valves, the upper grating is 11 in. wide, and it is 22 in. from the forward end to the face of the thrust coupling. The h.p. cylinder is 1$\frac{13}{32}$ in. in diameter, the i.p. 2¼ in., the l.p. 3$\frac{31}{32}$ in., and stroke is 2½ in.

Piston and valve rods are stainless steel fitted with metallic packing. Valve liners are also stainless steel, the l.p. valve being of the double-ported flat type. Every part of the engine was made by Mr. Hood from iron and bronze castings, bar brass and steel, and copper and brass pipe. Patterns were made in the orthodox way, although he found it necessary to build up the core system of the cylinders completely in wood in order to get proper wall thicknesses. Core boxes were made mostly of aluminum, so they could be machined more precisely on Mr. Hood's 12-in. lathe with milling attachment.

Model 17¼ in. high of a triple-expansion condensing engine



Condenser tubes were made tight in what is probably a rather novel way. Tubes were ⅛ in. O.D. To avoid making screwed ferrules as small as this, tubes were expanded in tight in one tube plate. The other tube plate was made in two parts, an outer section, or ring, fitting in between the condenser flange and outer head, and an inner section. The inner section is rectangular and equal in outline to the inside of the condenser body and has the other ends of the tubes expanded into it. This is scraped to fit the outer section, or ring, and a sort of stuffing box formed at the seam between the two sections. Into this seam, lead is caulked and held in place by the head. This joint proved tight when filled with hot water.

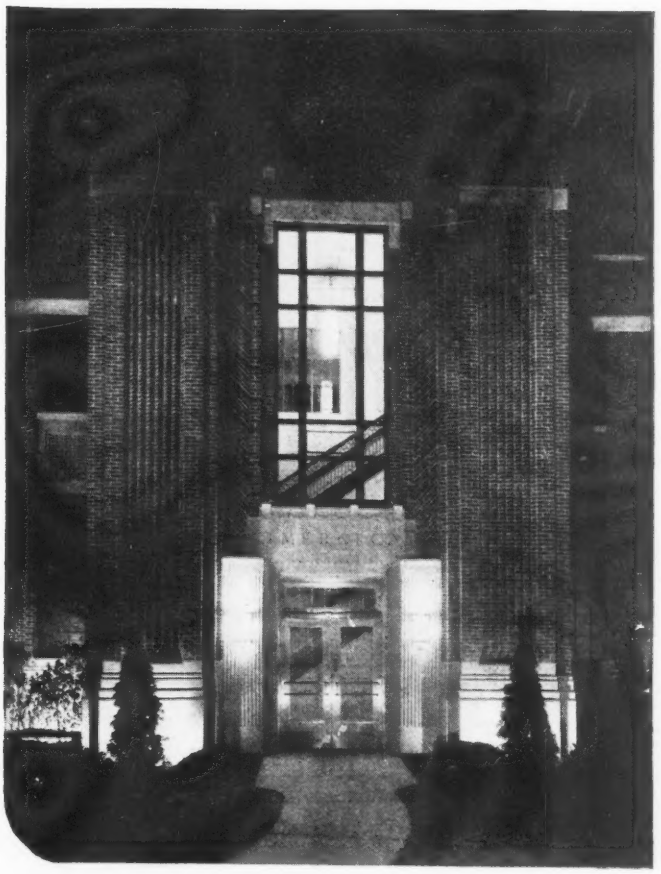
And Now Boilers

Mr. Hood is now busy on a design for two Scotch marine boilers for the engine, but so far hasn't been able to find anyone small enough to get inside and expand the tubes and buck-up for the riveter. He'll probably end up with a design modified somewhat from the orthodox.

PORT WASHINGTON TIES IN

By Thomas Wilson

One boiler and tandem-compound turbine, 1,230 lb. and 825 deg., pulverized-coal firing, low-heat-release furnace, radiant and convection superheating, flue-gas mill drying, 5- stage bleeding to heat feedwater



DURING the first week of September, the new high-pressure plant of The Milwaukee Electric Railway and Light Company at Port Washington, Wis., was officially dedicated. Open house was maintained for seven days, while over 36,000 guests visited the latest and one of the country's most modern power plants. Intricacies of design and operation were explained over loud-speaker stations.

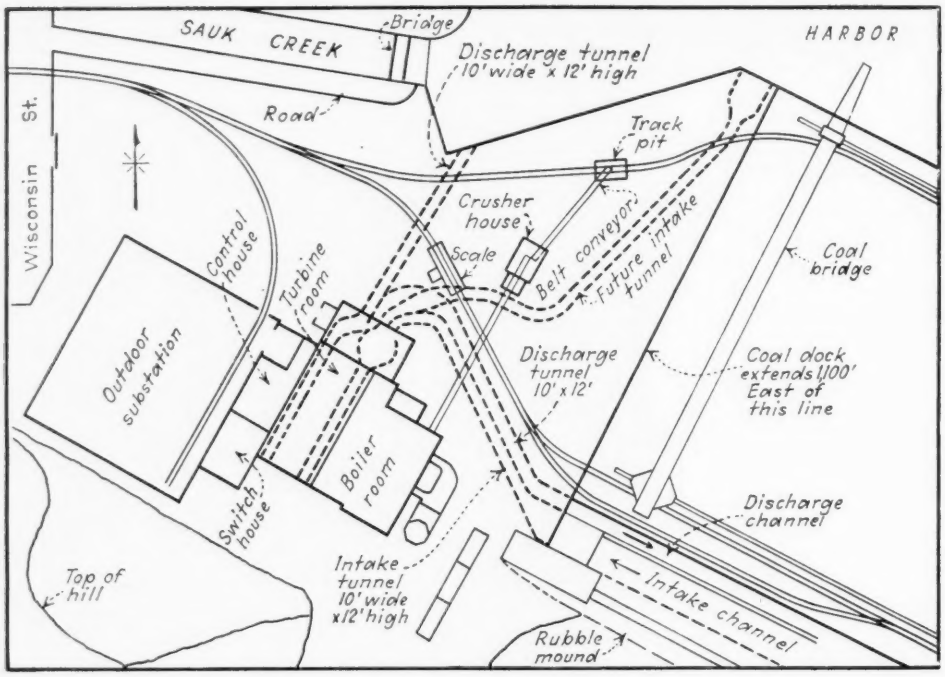
The plant was placed in operation about the middle of October. One 80,000-kw. turbo-generator operating on steam at 1,230 lb. pressure and 825 deg. F. temperature comprises the initial installation. Ultimate generating capacity of 400,000 kw. in five units is probable. On Lake Michigan, 28 miles north of Milwaukee, the location is ideal for the second source of electrical supply for the Milwaukee district. The new plant is at the north end of a 132,000-volt transmission loop around the metropolitan district, with Lakeside station at the south end. It is as close as practical to the electrical load center, has an abundant supply of cold condensing water, good harbor facilities for lake coal boats, and, through the company's own railroad, has advantageous rail connections to bring in midwestern coals should a change in freight rates and coal prices make it desirable.

Fundamentally, design of the new plant follows closely that of the high-pressure section of Lakeside. Operating experiences in the older plant were invaluable, particularly in boiler and furnace design. Variations from Lakeside are represented by the unit design at Port Washington, consisting of one boiler for each turbine-generator, one set of transformers, one 132-kv. transmission line, and one set of auxiliaries; adoption of 825 deg. F. steam temperature for both throttle and reheat, and generating of electrical energy at 22,000 volts. Flexibility of design is outstanding, making it readily possible to adopt in extensions any advances in the art.

Over a period of years analytical studies had been made by the company to determine, for conditions at Port Washington: most efficient steam cycle, including mercury-steam and Benson cycles; most economical steam pressure and temperature; size of unit giving lowest operating and investment costs; relative advantages of radiant and convection surfaces for superheater and reheater; relative adaptability to the plant layout of bin-and-feeder and unit systems for powdered coal, comparative advantages of economizers and air heaters as waste-heat reclaiming surfaces, and size and type of turbine to be installed. Conclusions reached were presented two years ago before the 1933 A.I.E.E. summer convention by G. G. Post, vice-president in charge of power. An abstract appeared in *Power* in July, 1933, giving considerations underlying design and selection of equipment. In making preliminary layouts, a wooden model built to scale of the initial installation avoided interference of piping and simplified location of component parts.

3-Drum Bent-Tube Boiler

With a capacity of 690,000 lb. of steam per hr., the boiler has more than twice the output of the largest



Tunnels and general plan of Port Washington power plant

Lakeside boiler. It is operated at 1,320 lb. pressure, with a maximum steam temperature of 850 deg. F. A 3-drum bent-tube boiler fired with powdered coal from one side, with a low-heat release furnace below it, was selected. Solid forgings machined inside and out, all three drums are 40 in. inside diameter with seamless shells $5\frac{1}{4}$ in. thick. The two upper drums weigh 70 tons each, are 62 ft. long, the longest it is possible to build with equipment available. They are suspended from slings which support the weight of all tubes and the mud drum, including the waterwall tubes, thus making the entire boiler a flexible unit that can expand and contract. The 2,200 boiler tubes are 3 in. outside diameter with walls $\frac{5}{16}$ in. thick. Banks are arranged 110 tubes wide and 20 tubes deep. Steam-making surface aggregates 44,087 sq.ft. (These figures exclude water-walls and ash screens in the furnace).

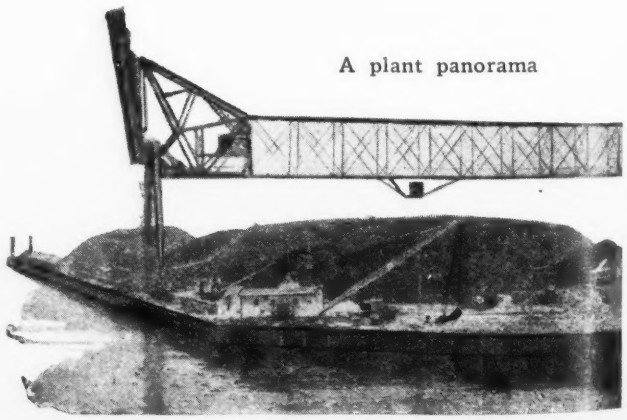
Radiant surfaces for these equipments were prompted by economic considerations and adaptability of these surfaces to the low-heat release furnaces of both Lakeside and Port Washington. More uniform steam temperatures over wide load ranges can be obtained automatically, particularly at low loads, for better over-all station economy. The superheater is a combination radiant and convection type. The radiant section, with 1,464 sq.ft. of projected tube area, is in the two side walls of the furnace. The convection superheater, with 8,700 sq.ft. of surface, has been placed behind the first bank of tubes in the boiler. By passing the steam first through the radiant superheaters, made of special alloy chrome molybdenum, the metal temperature of the tubes in this section is kept lower. With the combination it has been estimated that steam temperature to the turbine throttle will vary from 830 deg. F. at full load to 802 deg. at quarter load. With the reheater (all radiant surface chrome-nickel alloy) located in the rear wall of the furnace, a temperature drop of only 7 deg. (from 834 to 827 deg. F.), over the same load range is anticipated. By means of 1,740 sq.ft. of surface in the radiant reheater, interstage steam from the turbine is raised to the initial temperature of 825 deg.

At Lakeside it had been proved conclusively that a furnace of large volume is conducive to low maintenance costs and high availability. A slag-tap furnace of relatively small size and of high temperature to keep the slag molten would have precluded use of radiant superheaters and reheaters. The furnace therefore was given a volume of 58,000 cu.ft. At maximum boiler rating, heat release is under 15,000 B.t.u. per cu.ft. per hr. Mean furnace temperature approximates only 2,100 deg. F. The furnace is lined on all six sides with steel walls consisting of radiant superheater and reheater steam-cooled surfaces for side and rear walls and water tubes for the front wall and ash screen. Waterwall and screen surface totals 7,690 sq.ft. With a furnace of such magnitude, over-all dimensions of the boiler unit are interesting. Height is 92 ft., width 60 ft. and depth from front to back, 30 ft.

Gas makes four passes through the boiler, then discharges directly into two plate-type air heaters with a total of 121,000 sq.ft. of plate area, and then through a steel breeching to a 300-ft. concrete stack of $15\frac{1}{2}$ ft. inside top diameter. At full load, air temperatures from the heaters will approximate 630 deg. All air will be used for combustion purposes. To meet load requirements more readily two forced-draft, two induced-draft and two primary-air fans are provided. All are driven by variable-speed slip-ring motors.

Pulverized coal is fired downward into the furnace through twenty burners of the forced-draft type, the flame curving back and upward to the boiler surface. Secondary combustion air is introduced through the front furnace wall. Ten duplex feeders driven by variable-speed d.c. motors supply the burners. Two 15-ton impact roller mills prepare fuel. A feature is flue-

A plant panorama



gas mill drying of the fuel similar to the Lakeside installation, described in *Power* April 22, 1930. About 6% of the flue gas, at about 550 deg. F. and containing 15% CO_2, is drawn off the air-heater casing and introduced into the mill circuit between exhauster and mill. In the mill system and exhauster, 12% CO_2 is maintained, so that danger of fire or explosion from smoldering coal is lessened. After passing through the mill, gas temperature is reduced to 150 deg., as compared to 340 deg. at the air heater outlet. This difference in temperature, plus improved air-heater performance from the greater ratio of air flow to gas flow, tends to increase boiler-room efficiency. Trouble from corrosion is obviated by insulating piping and collectors. Auxiliary collectors return to the top of the mills most of the fine coal suspended in vent gas, so fuel loss is insignificant.

Storage System of Firing

Following precedent at Lakeside, the storage system of pulverized-fuel firing was adopted. Closer regulation, load-carrying reliability, flexibility and higher economy from various reasons were determining factors. To conserve building cost, green-coal storage capacity in the boiler room was held to 1,100 tons, sufficient to carry the plant over a week-end. Near proximity to large dock storage made this possible. A pulverized-coal bunker capacity of 290 tons is sufficient to permit shutting down the mills during one shift and during peak-load periods.

Storage Dock for Raw Coal

Eastern bituminous screenings transported by water from lower lake ports is burned. It is received on a storage dock having capacity for 330,000 tons of coal, sufficient to supply the ultimate plant. A coal bridge handles unloading, storing and reclaiming. With a 10-ton clamshell bucket it has an unloading capacity of 600 tons per hour. Span between shear and pier legs of the bridge is 422 ft. A cantilever which can be raised extends beyond the pier leg about 95 ft., thus making hatches of widest-beam lake carriers accessible.

Coal for plant use is reclaimed from the stock pile into a bin in the pier leg of the coal bridge, then spouted into hopper cars for a short haul to a track scale and dumping pit. A direct rail connection to the company's line for the dock opens an outlet for coal to neighboring territory and an inlet for rail-borne coal. From the dumping pit, apron conveyors transfer coal to a belt conveyor leading to the crusher house, where a magnetic pulley, grizzly and crusher prepare it for delivery to the plant. An inclined-belt conveyor performs this service.

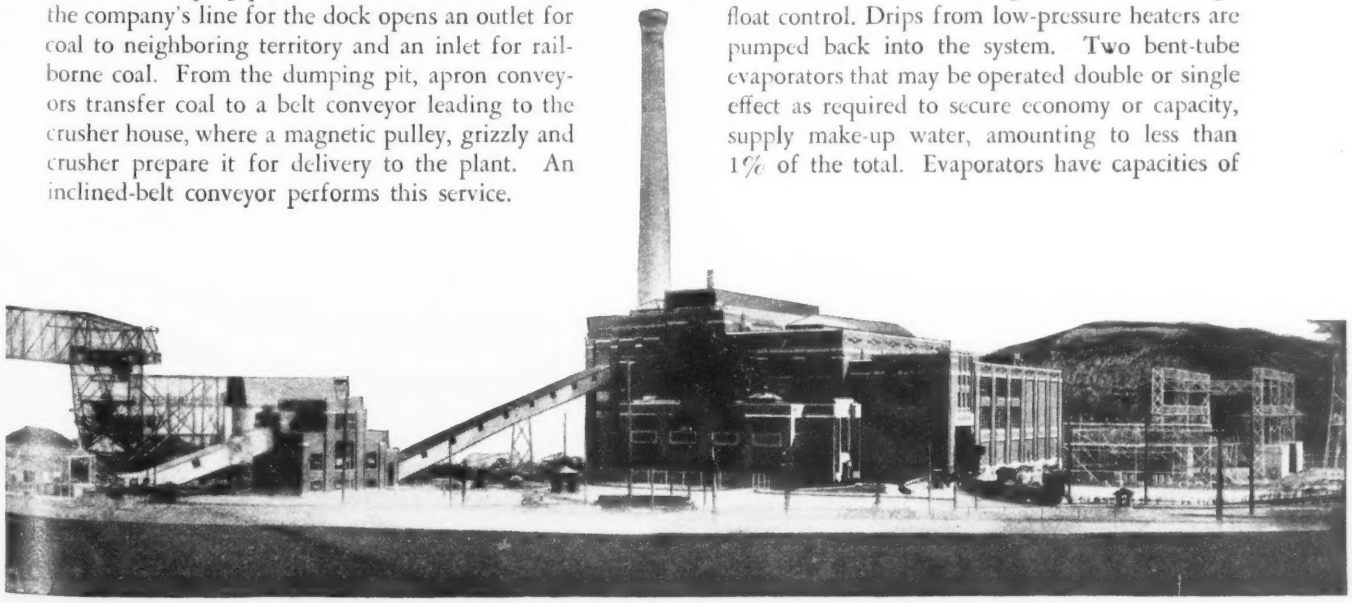
Steam is extracted for feedwater heating from the turbine at five points, the highest being at the point where steam is taken to the reheater. A total of eight heaters for the five extraction points is provided, two each for the three higher points and one each for the two lower points. The flow diagram shows how the hot-well pumps discharge through the steam-jet air pumps, the generator air cooler and the two lower-stage heaters, Nos. 1 and 2, to the suction of the boiler-feed pumps. At this point four large surge tanks at a high elevation float on the line to take any excess or supply any deficiency in feedwater. Additional storage at the same level can be provided by a pair of weighing tanks on platform scales provided primarily for testing.

Three identical 8-stage feed pumps operate against maximum head of 1,800 lb. and handle feedwater up to 220 deg., each being capable of delivering 375,000 lb. of water per hr. Two are motor driven for regular service, and one steam driven for standby. By locating the pumps between the low- and high-pressure heaters, one of the most serious handicaps to successful high-pressure plant operation is avoided, that is, widely fluctuating water temperatures to the pumps. Owing to the comparatively cool water (200 to 220 deg.), pumping costs also are lower.

Heaters

Although the pumps are connected to a common header, each of the two for regular service will discharge through its own series of three extraction heaters directly to the boiler. By equalizing pressure at the boiler drum through separate feed lines, hunting in the pumps at light loads is minimized. Besides, loss of one feed pump or any one of the high-pressure heaters will not shut down the station, because the other set will permit operation at better than half load.

The high-pressure heaters have all-welded shells and forged-steel heads made integral with the tube sheets. Head covers have pressure applied from the inside, thus gaskets do not withstand bolt pressure in addition to that exerted by the water. Drips from the high-pressure heaters are cascaded from one to the other in order of pressure. Decrease in flash losses is accomplished by sub-cooling or refrigerating drips in heaters Nos. 4 and 3 by submerging bottom tubes in the heaters and maintaining water level through float control. Drips from low-pressure heaters are pumped back into the system. Two bent-tube evaporators that may be operated double or single effect as required to secure economy or capacity, supply make-up water, amounting to less than 1% of the total. Evaporators have capacities of



10,000 lb. per hour each. They are preceded by a bent-tube preheater open to the atmosphere through a vent condenser. Raw water comes from the house supply system, passing through a standard sand filter on its way to the preheater. In the latter, temperature is raised to 212 deg. by steam from the auxiliary exhaust header to drive off the oxygen and temporary hardness. In case of a shortage of exhaust steam, pressure regulating valves admit bled steam to the mains. From the preaheater, water is pumped into the evaporators to be vaporized and later condensed in No. 2 extraction heater. Drips from evaporator coils are also received in this heater, and total condensation is pumped into the feedwater system. The evaporators may be operated intermittently or continuously as required. The indicator and the alarm on the surge system help the operator in regulating the amount of make-up.

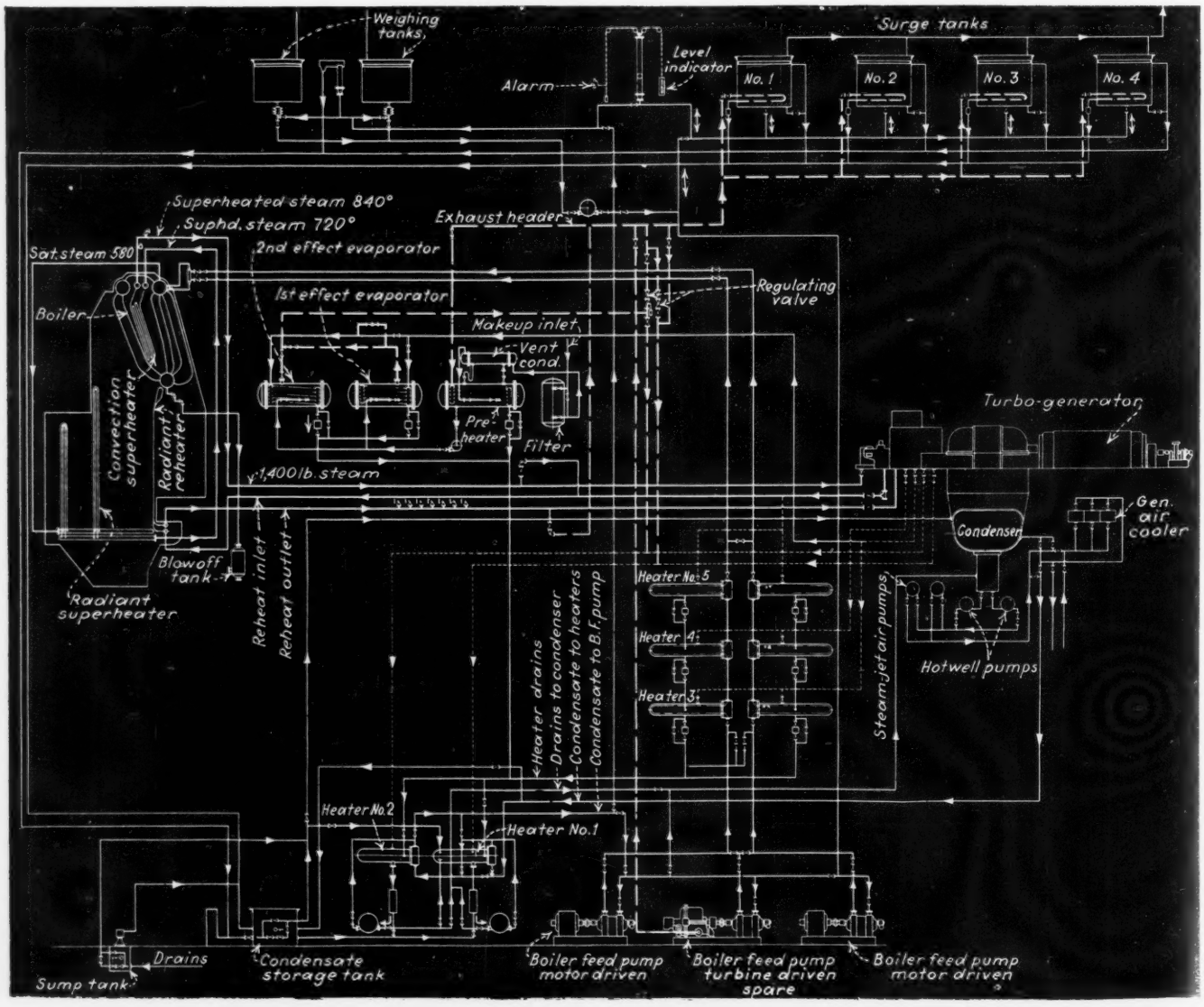
In regulation of these high-pressure boilers, assurance of maximum reliability is a primary factor. A boiler meter actuates the coal and air feed, but with only 6 min. storage of water in the boiler drums at full load the operator must know at all times how much water is entering the boiler without waiting for level to vary. He is stationed in the vicinity of the control board where steam pressure and steam flow, water level (through a periscope) and feedwater flow may be visualized and adjustment made by means of two hand-operated feedwater control valves in front of the control board. As at Lakeside, no automatic feedwater regulators are used. Instead, a recording feedwater flow meter next to the steam-flow meter gives information that reduces control effort to a minimum. The two records are kept continuously coincident. When load changes, the feed rate is varied with the steam flow, and water level checked through the periscope.

Studies on the size and type of generating unit resulted in the decision to install a tandem-compound reaction turbine of 80,000-kw. capacity at 85% power factor. Normal speed of the unit is 1,800 r.p.m. Steam pressure at the turbine throttle is 1,230 lb. gage and steam temperature 825 deg. F. Vacuum at the turbine exhaust nozzle is 29 in. of mercury.

Five extraction points have been arranged for feedwater heating and for interstage reheat of turbine steam. Pressure at the reheat point is approximately 422 lb., abs. at full load and decreases with lesser loads. Temperature of interstage steam in the high-pressure cylinder is restored to a total temperature of 825 deg. F. by the radiant reheater in the boiler furnace. Steam is exhausted from the high-pressure cylinder at about atmospheric pressure.

To insure an even distribution of heat, boiler steam enters the high-pressure cylinder at top and bottom. For the sake of simplicity and symmetry, steam valves

FLOW DIAGRAM FOR THE INITIAL 80,000-kw. INSTALLATION



are in a separate steam chest. Three steam valves open successively as load is increased. Admission of reheat steam is to the center of the high-pressure cylinder. Flow in the high-pressure cylinder is in one direction while in the low-pressure section, double flow in opposite directions is used. The latter construction minimizes the length of the last rows of blading, making it possible to hold to a maximum tip speed of 872 ft. per sec. in the last row.

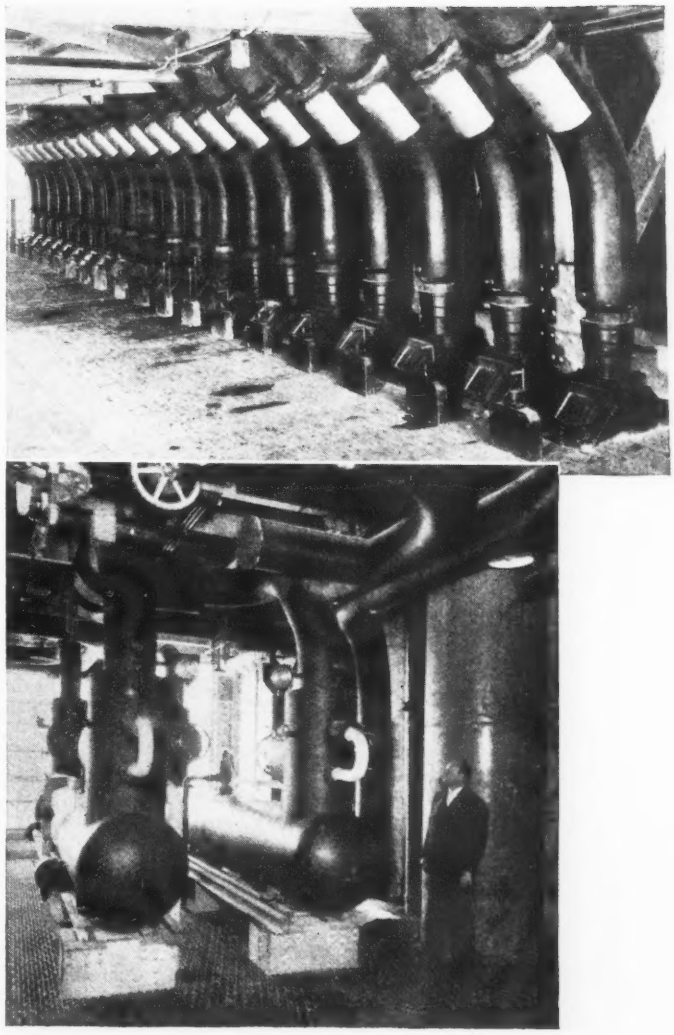
Approximate over-all length of the unit is 95 ft. 3 in.; width, 32 ft. 7 in., and height of the highest point above the floor, 15 ft. 6 in. Of the total shipping weight of 1,720,000 lb. for the unit, the high-pressure spindle weighs 71,000 lb., the low-pressure spindle 70,000 lb., the generator rotor 211,000 lb. and the generator stator 333,000 lb.

Small Surface Condenser

Five-point bleeding permitted use of a relatively small surface condenser, a single-pass type with 52,500 sq.ft. of surface, or 0.656 sq.ft. per kw. of generator rating. $\frac{7}{8}$-in. diameter tubes are rolled into the tube sheets at each end. To provide for expansion, the tube sheet and water box at the discharge end are of the floating type with a welded-steel expansion joint between tube sheet and condenser shell. A deaerating hot-well assists in keeping oxygen out of feedwater. An air cooler with 1,150 sq.ft. of surface is outside the condenser shell. Auxiliaries consist of two twin-evactor 3-stage steam-jet air pumps and two circulating water pumps having a total capacity of 110,000 gal. per min. when operating together and 73,000 gal. per min. when operating singly. Circulating water is drawn from the lake. Traveling screens are in the basement of the plant.

The 3-phase, 60-cycle, 22,000-volt generator has a directly-connected 300-kw., 250-volt, main exciter and a 5-kw. pilot exciter mounted on its shaft. Exciter rheostats are remotely controlled and provision has been made for future application of quick-response excitation. For generator air cooling, a relatively small enclosed-type cooler has been adopted to use condensate or raw water. Raw water will be needed only after condensate temperature reaches 75 deg. F. With Lake Michigan water, this will be for only a few months each year. A separate ventilating system for the cooler consists of two fans, each driven by a 200-hp. motor.

Factors influencing selection of generator voltage were: over-all cost was lowest; no pioneering in generator voltages was desired; economical connection to bus bars for industries that might locate in the vinicity; and connection to the existing 26,400-volt secondary transmission lines with a minimum of expense, even though most of the current will be stepped up directly to 132 kv. All 22,000-volt switching equipment is indoors in preference to outdoor metal-clad construction. Influencing factors were the necessity for a transformer repair house and control house, economies that would be effected and other advantages, such as the greater ease of making changes from the original lay-out. Arrangements were made for vertical isolated phase construction and a fault bus to protect the entire 22,000-volt bus and switching equipment.



Top—Burner deck, showing 20 vertical pulverized-coal burners serving the 690,000-lb. per hr. boiler. Above—No. 5 high-pressure extraction heaters which take steam from cross-over line leading from turbine to reheater

Initially there will be no house unit. Auxiliary power for the station will be obtained from two sets of auxiliary transformers, one set connected to the generator leads, the other to the station bus. In case of complete outage, the auxiliaries will draw on the bus, which will be energized by incoming transmission lines. Motors over 100-hp. capacity are supplied at 2,300 volts, and smaller motors at 460 volts. Two 300-kw. motor-generator sets backed by a 240-volt storage battery, supply direct current for pulverized-coal feeders, electrically operated valves, turbine-room cranes, emergency lights and magnetic pulley. One emergency boiler feed-water pump and one emergency house service pump are the only steam-driven auxiliaries.

The outdoor substation adjacent to the plant contains two 10,000-kva., 26,400-volt auto-transformers to step up generator voltage to that of the surrounding secondary transmission lines; also a 90,000-kva. bank consisting of three 30,000-kva. transformers and one spare, connected delta-Y with the high side neutral solidly grounded. The latter will deliver the bulk of the load to the 132-kv. system.

MULTIPLE V-BELTS

Construction...Selection...Operation

Only when all factors are considered can a V-belt drive be selected properly. Poor selection leads to loss of power and generally poor operation, both of the drive and of the driven unit

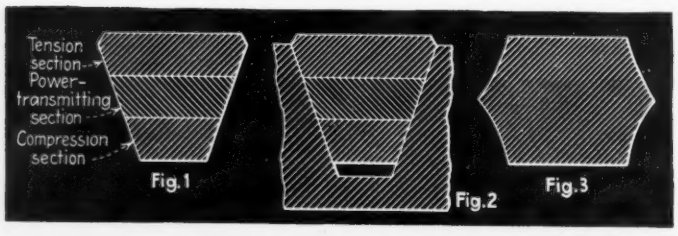
WHERE it can be used economically, a direct-connected motor makes an almost ideal drive. In most power applications, however, the preferred speed of the driven machine does not correspond with that of the motor. It is therefore more economical to use some form of mechanical power transmission to connect the two, rather than attempt to match the speeds of the driving and driven shafts. One of several types of drives for this purpose is the V-belt, marketed under several trade names. On most industrial V-belt drives, two or more belts are operated in parallel, and these arrangements are generally known as multiple V-belt drives. Large drives may have 20 or more belts in parallel.

Construction

All V-belts are of rubber and cotton construction, although varying in design with the maker. They are trapezoidal in cross-section, Fig. 1, and run on grooved pulleys as in Fig. 2. In some modern drives, only the smaller pulley is grooved, the larger pulley having a flat surface. Originally a V-belt drive was intended to operate on straight, open applications, but recently has been developed for most services where flat belts can be used. These include quarter-turn drives with and without idlers. V-belts are also used where power must be transmitted to grooved sheaves from both belt tops and bottoms. Such belts are made with a so-called double-V cross-section, Fig. 3. Adjustable-pitch-diameter sheaves are now available that permit up to 50% speed adjustment.

Three outstanding advantages of V-belts are their ability to operate on very short centers, silence and high efficiency. Since several strands generally operate in multiple, one may fail without being as hazardous or causing a shutdown, as would failure of a flat belt or chain drive. V-belts operate quietly, are clean, require no oil or belt dressing, absorb shocks, and prevent transmission of vibration from the driven to the driving unit, just as a flat belt will. They operate with low tension in the belts when properly applied, therefore have low maintenance and are easy on motor bearings.

Fig. 1—Cross-section of V-belt. Fig. 2—V-belt in sheave groove. Fig. 3—Cross-section of double V-belt



These belts should not be used where they will be subjected to continuous contact with mineral oil or where the distance between centers cannot be adjusted. Since they are of rubber and fabric construction, temperatures in excess of 140 deg. F. will injure them. If used in the presence of excessive moisture, they should have additional capacity as water reduces their coefficient of friction.

Manufacturers of V-belts and sheaves have standardized their equipment fairly well and have published comprehensive engineering data for its application. There are only five standard cross-sections of belts, and all drives are made up by choosing one or more belts of a cross-section that best suits a particular set of conditions. Conditions include belt speed, size of sheaves, ratio of driving-sheave diameter to driven-sheave diameter, center distances between sheaves, horsepower to be transmitted, type of load, characteristics of load and power drive, and how started.

Multiple V-belts may be operated in either a horizontal or a vertical position and in either direction, but the preferred installation is horizontal with the slack side on top. They are essentially short-center drives but may be operated on fairly long centers, belts being listed to operate on 20-ft. centers. Speed ratios of from 1:1 to 1:7 are standard practice. Higher speed ratios up to 1:10 are possible, but the manufacturer should be consulted before such installations are made.

As previously mentioned, these drives may also be used on special applications, such as quarter-turn, and where both sides of the belt must come in contact with the sheaves. Standard belts may be operated at speeds up to 5,000 ft. per min., but speeds up to 6,500 ft. per min. or higher are permissible when proper considerations are given to drive selection.

Ratings

V-belts, like other mechanical-power transmission equipment, have definite limits that should not be exceeded if best service is to be obtained. Horsepower ratings of the five different belt cross-sections, as given by manufacturers, are based on 180 deg. of contact on the small sheave, and 1:1 ratio. For other speed ratios, a correction factor must be used, varying from 1 for 180 deg. of contact to 0.48 for 60 deg. The latter is an extreme, but it emphasizes the need for considering arc of contact when selecting a drive. These belts transmit less than half their normally rated power when operating on 60-deg. contact.

The type of load and how it is driven are also important. For light-running machinery driven by motors, with controlled starting current, belts may be selected

on a basis of motor capacity, due consideration being given to other factors. Where load is heavy and pulsating or high starting torque is required, motor horsepower rating should be increased by at least 50% to obtain the horsepower for selecting the belt.

When the motor is started by connecting directly across the line, use an additional factor of 1.3. In other words, if a heavy pulsating load is to be started by connecting the motor directly across the line, then the horsepower rating of the belt should be Motor Rating x 1.5 x 1.3, or twice normal motor rating. If the arc of contact on the small sheave is 140 deg., normal belt capacity will be reduced 10% therefore the belts selected for the drive, based on manufacturer's rating, should have about 220% of normal motor rating. From the foregoing, it is quite obvious why a multiple V-belt, or any other drive, may prove unsatisfactory when proper consideration is not given to all influencing factors.

Belt speed influences cross-section of the belt selected. The higher the belt speed the smaller the belt cross-section. This means more belts and probably wider sheaves. Using lighter belts reduces the centrifugal force acting on any one strand of the belt and decreases the work done on it internally due to bending around the sheaves. If the belt is worked too hard internally due to bending and other causes, its temperature will be excessive and its life short.

Limits of Sheave Size

There are definite limits for the size of the smaller sheave and the cross-section of belt used on it. For example, a minimum sheave pitch diameter of 4 in. is recommended for the smallest standard V-belt, and about 22 in. for the largest. The large-size sheave for the heaviest belt is required to keep down the internal work done on it so that its temperature will not be excessive. Also, when a belt bends around too short a radius it tends to distort and to not contact sheave grooves properly. This causes loss of power and efficiency due to slippage and heating.

Common-Sense Engineering

Do not draw the conclusion from the foregoing that V-belts are difficult to select; they are not any more so than other types of mechanical power-transmission equipment. They all must have common-sense engineering put into their selection if satisfactory low-cost service is to be obtained. A little excess capacity will pay good dividends on the added investment, while lack of capacity will be a continual source of annoyance and expense.

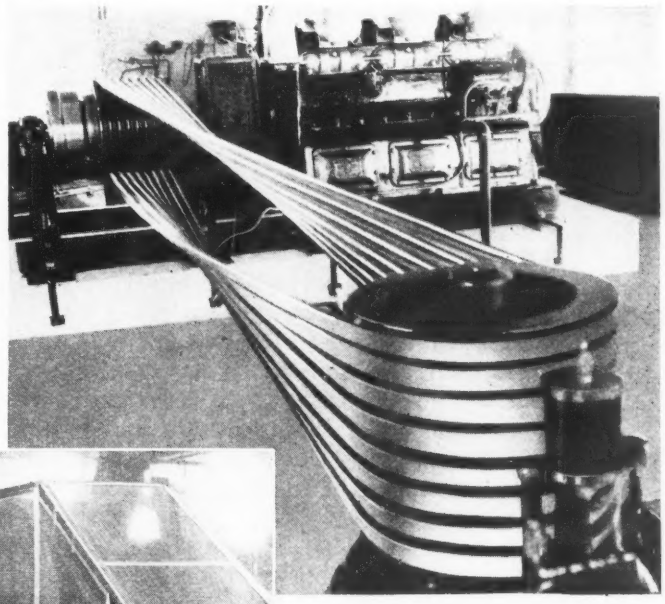


Fig. 6 (Above) — A 125-hp. diesel engine drives a vertical deep-well pump through a quarter-turn multiple V-belt

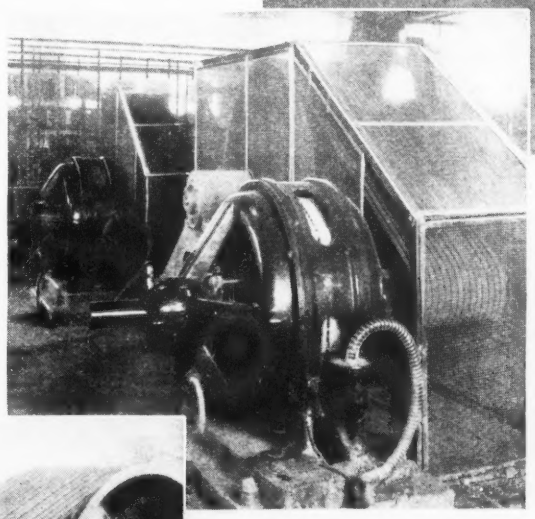


Fig. 5 (Right)—Two 125-hp. synchronous motors connected to their loads by multiple V-belts

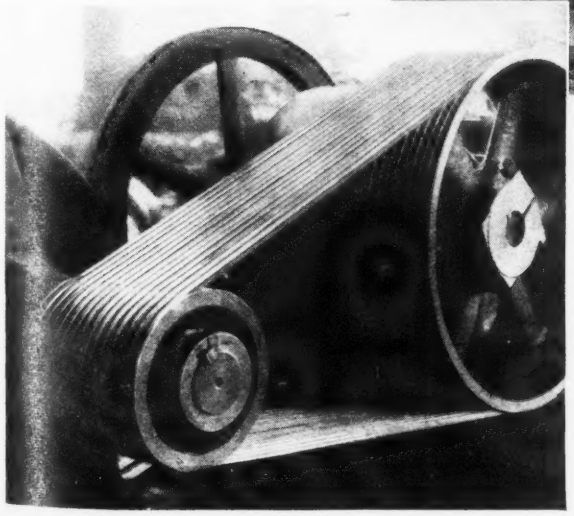


Fig. 4 (Below)—Heavy-duty multiple V-belt connects wound-rotor induction motor to air compressor

MORE WATER, PLEASE—Increasing use of air-conditioning machinery soon will overtax the nation's water supply. Twice as much equipment was sold in 1934 as during 1933. Within three to five years, it's use will multiply water consumption tenfold, and water plants will have to be remodeled to meet the demand.—A. R. McGonegal, chief plumbing inspector, Washington, D. C., in *N. Y. Herald Tribune*.

HOW MANY DIESELS—WHAT SIZE

Capacity, service and load are the factors which govern selection of size and number of diesels. Here are D.E.M.A. suggestions*

CERTAIN considerations should be given careful study in selecting the number and capacity of diesel-generator units to be installed to handle any specific load without other power connections. These are:

1. *Capacity*—The total capacity of the unit or units should not be less than the peak load to be handled at any time and preferably should be greater by a margin allowing for an increase in peak load which may have to be carried before it is expedient to install an additional unit.

2. *Character of Service*—If a complete cessation of service cannot be tolerated, at least two units should be installed so that either one can be shut down occasionally for routine inspection and maintenance. Such continuous service does not necessarily imply a continuity of heavy load, but rather a 24-hr. load the year round, which may be of a fluctuating demand. This is the type of load served by utility plants.

3. *Character of Load*—Besides the duration, as covered in (2), the character of the load is important—that is, whether it shows little or wide variation. Such data can be best analyzed when plotted in curve form.

To illustrate this method of analysis, a load curve is presented in Fig. 1. This is a curve such as might result from smoothing out a recording watt-meter chart. If no such meter record is available, the day can be divided into suitable intervals and the average demand plotted for each interval. The length of the interval depends upon the load variation; if the load changes gradually, the interval may be long, but if the load fluctuates rapidly, the interval should be short—as little as 15 min. in extreme cases. For almost every case there will be seasonal variations in the daily demand curve. It will then be necessary to divide the year into intervals, with a daily demand curve typical of each interval. Here again, the optimum length of the intervals will depend upon the rapidity with which the daily demand curve shifts. If the change from season to season is gradual, four daily demand curves should be sufficient. Since only a method is being illustrated here, it will be assumed that there is no seasonal variation and that the curve in Fig. 1 is reasonably average for the 365 days of the year.

If the curve in Fig. 1 were indeed typical for each day in the year, with no appreciable seasonal variation, the graphical analysis could stop at this point, but since seasonal variation is the rule, a further step will be taken. By dividing this typical day into 24 hourly intervals and obtaining the average demand for each from Fig. 1, Table I can be prepared.

For a seasonally varying load, such a table should be prepared for each division of the year. The duration in hours of each demand, if the day is divided into 24 hourly periods, as in this illustration, will be equal to the number of days in the particular season.

The demands appearing in Table I should next be rearranged in the order of decreasing magnitude, grouping any equal demands. From this table, the curve in Fig. 2 can be plotted.

Table I—Demand for Power

Time	Mean demand in gross kw.	Duration per year in hours	Gross kw.-hr. per year
Midnight to 1 A.M.	340	365	124,100
1 A.M. to 2 A.M.	335	365	122,275
2 A.M. to 3 A.M.	340	365	124,100
3 A.M. to 4 A.M.	350	365	127,750
4 A.M. to 5 A.M.	370	365	135,050
5 A.M. to 6 A.M.	400	365	146,000
6 A.M. to 7 A.M.	435	365	158,775
7 A.M. to 8 A.M.	490	365	178,850
8 A.M. to 9 A.M.	555	365	202,575
9 A.M. to 10 A.M.	630	365	229,950
10 A.M. to 11 A.M.	695	365	253,675
11 A.M. to Noon	760	365	277,400
Noon to 1 P.M.	810	365	295,650
1 P.M. to 2 P.M.	830	365	302,950
2 P.M. to 3 P.M.	820	365	299,300
3 P.M. to 4 P.M.	825	365	301,125
4 P.M. to 5 P.M.	870	365	317,550
5 P.M. to 6 P.M.	975	365	355,875
6 P.M. to 7 P.M.	1,100	365	401,500
7 P.M. to 8 P.M.	1,250	365	456,250
8 P.M. to 9 P.M.	1,320	365	481,800
9 P.M. to 10 P.M.	1,150	365	419,750
10 P.M. to 11 P.M.	730	365	266,450
11 P.M. to Midnight	420	365	153,300
Total gross kw.-hr. per year			6,132,000

For a peak load of 1,320 kw. it is probable that 1,500 kw. total capacity will allow for a reasonable increase in load before another unit must be installed. This capacity could be subdivided in various ways, but usually practical considerations will hold the number of units to two or three. It remains to make a choice between two 750-kw. units and three 500-kw. units.

In neither case will there be 100% standby capacity, nor should this be necessary for such a load curve if a properly ordered maintenance schedule is observed. All three units of the 3-unit plant must operate for 4 hr. each day, leaving 20 hr. during which any one unit can be shut down for inspection and maintenance. Both units of the 2-unit plant must operate less than 12 hr., leaving 12 hr. when either unit could be shut down. The shorter period should be sufficient. Undoubtedly there will be week-ends and off-days when the period of possible shutdown for one unit will be much longer, perhaps over 24 hr. It is difficult to see where the 3-unit plant has any material advantage in reliability over the 2-unit plant.

The economic choice between the two plants is a question of balance between lower fixed charges for the 2-unit plant and lower fuel and lubricating oil cost for the 3-unit plant. No one could say which plant would show the lower maintenance cost; probably the two would be about on a par. Certainly the same attendance force could handle either plant, so labor costs would cancel out.

*Condensed from Chapter III, "Selection of Diesel Sizes for a Given Load," of *Standard Practices of Diesel Engine Manufacturers' Association*, soon to be published by the Association and to be available from Diesel Publications, Inc., 192 Lexington Ave., New York, N. Y., for $2.

Examination of Fig. 2 will show that the running hours per year would be as follows:

3-unit plant—	
All three units, hours	1,460
Two units, hours	4,015
One unit, hours	3,285
Total, hours	8,760
2-unit plant—	
Both units, hours	4,015
One unit, hours	4,745
Total, hours	8,760

Fuel and lubricating oil cost for either plant will vary with the per gallon cost of these commodities and with the plant-running-capacity factors. The plant-running-capacity factor in either case will be the percentage relation between the gross output and the rated kilowatt-hours (kilowatts $\times$ hours operated). Therefore, for the 3-unit plant, p.r.c.f. =

$$\frac{6{,}132{,}000 \times 100}{1{,}460 \times 1{,}500 + 4{,}015 \times 1{,}000 + 3{,}285 \times 500} = 78.1\%$$

And for the 2-unit plant, p.r.c.f. =

$$\frac{6{,}132{,}000 \times 100}{4{,}015 \times 1{,}500 + 4{,}745 \times 750} = 64.0\%$$

The higher plant-running-capacity (p.r.c.f.) for the 3-unit plant is the result of the ability to follow the load curve more closely with the smaller units.

Probable fuel consumption at 78.1% p.r.c.f. would be at the rate of 1 gal. per 12.7 gross kw.-hr. At 64.0% p.r.c.f. it would be at the rate of 1 gal. per 11.7 gross kw.-hr. (Graphs, page 599). Assuming a cost of \$0.05 per gal., respective fuel costs would be:

3-unit plant; $\frac{6{,}132{,}000}{12.7} \times \$0.05 = \$24{,}140/\text{yr.}$

2-unit plant; $\frac{6{,}132{,}000}{11.7} \times \$0.05 = \$26{,}200/\text{yr.}$

Similarly for the lubricating oil, using the factors obtained from Fig. 2, page 599:

3-unit plant; $\frac{6{,}132{,}000}{1{,}890} \times \$0.50 = \$1{,}620$

2-unit plant; $\frac{6{,}132{,}000}{1{,}560} \times \$0.50 = \$1{,}960$

With all other operating cost items cancelling out, the advantage in operating cost in favor of the 3-unit plant would be the fuel and lubricating oil cost saving, or \$2,400.

On a basis of prices obtaining today detailed estimates have been made covering the respective first costs of these two plants under average conditions. The 2-unit plant would cost approximately \$21,750 less than the 3-unit plant, according to these estimates. A total fixed charge of 8.7% per year was held adequate. This percentage, applied to this difference, results in \$1,890 annual saving in fixed charges for the 2-unit plant. To recapitulate:

	2-Unit Plant	3-Unit Plant
Saving in fuel cost, year		\$2,060
Saving in lubricating oil cost, year		340
Saving in fixed charges, year	\$1,890	
Totals, year	\$1,890	\$2,400
Net saving for 3-unit plant, year		\$510

The foregoing quantitative comparison of the economics of 2-unit and 3-unit diesel power plants shows them to be nearly the same, with a slight advantage on the side of the 3-unit plant for the particular conditions assumed. It is readily apparent that different operating or other conditions may make an important change in the results of such an analysis.

In making such analyses, it should be borne in mind that there are factors to be taken into account which cannot be exactly evaluated. These are dependent chiefly upon the human equation and are covered principally by the question as to whether or not there can be any assurance that the plant operators will be sufficiently alert to take advantage of the potential flexibility of the 3-unit plant, so as not to have more units in one operation at any time than are absolutely necessary to carry the existing load safely to anticipate any impending peaks.

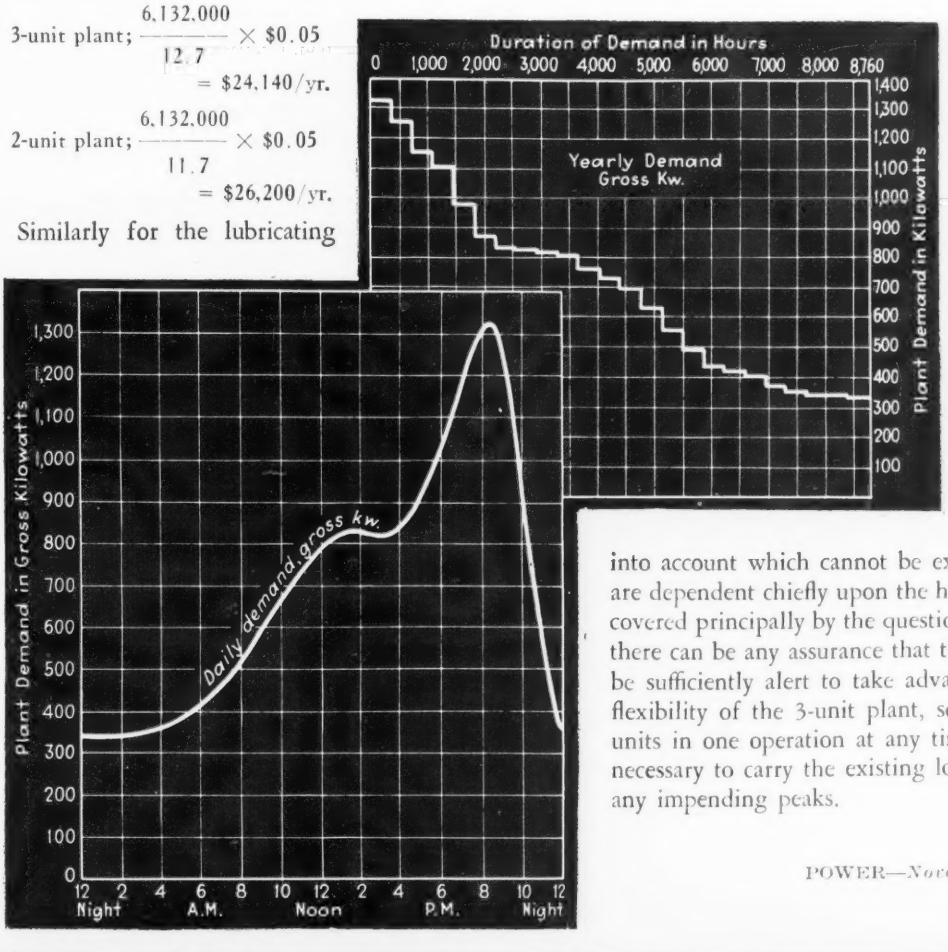


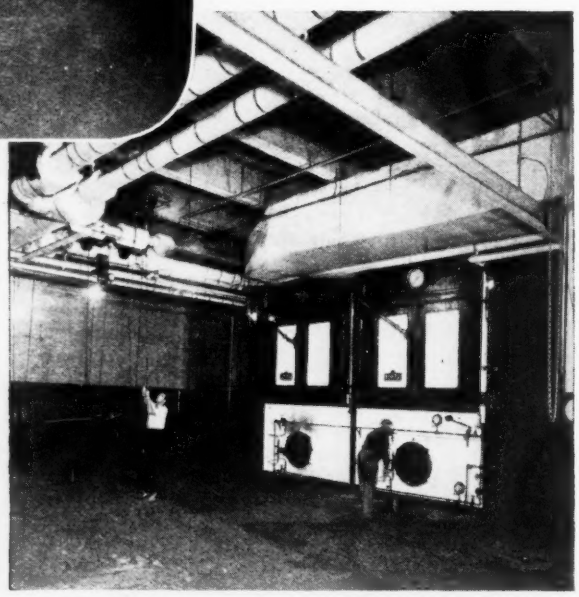
Fig. 1 (left)—Typical daily demand curve. Fig. 2 (above) — Typical yearly demand curve

UNIT HEATERS SAVE 118,000 GAL. OF OIL

By

Andrew J. Morrison

Chief Engineer, Heating Dept., Mack International Motor Truck Co.



Top—In this department of Mack Truck Co. two unit heaters replaced 36 radiators. Above—Steam supply to ten departments is controlled from the boiler room

BETWEEN May 1 and Sept. 1, 1934, we replaced most of the direct radiation formerly used to heat the Long Island City plant of Mack International Motor Truck Co. with unit heaters at a cost of about $6,000. As a result of this change and changes in the boiler setting, fuel oil required per year was reduced from 300,000 to 182,000 gal., a reduction in the fuel bill of over $3,000 a year.

The factory building is a 4-story concrete structure having 277,000 sq.ft. of floor area. The present heating system has a connected load of 55,000 sq.ft. of equivalent direct radiation including the unit heaters.

Before the change-over, the building was heated by cast-iron radiators placed along the walls, many of them under work benches. In addition there were a number of pipe coils placed under skylights, as can be seen from the pictures. The Ilg unit heaters replaced 25,000 ft. of 1-in. pipe coil, 200 radiators of 150 sq.ft. each, together with some 500 valves and traps. Radiation removed totaled 38,650 sq.ft. of equivalent radiation, and was replaced with 25,232 sq.ft. of unit-heater capacity in 29 units of the following capacities:

16	units	1,080	sq.ft. E.D.R.
11	"	646	" "
2	"	433	" "

These units are all of the ceiling suspension type, each comprising a heating coil of seamless copper tubes with extended fin surface and Ilg self-cooled motor propeller fan for air distribution.

Except for units installed under the skylights, all have been placed along the outside walls and arranged to create a circulation of air along the window surface. This arrangement is shown well by the picture of the carpenter shop, where three unit heaters suspended along the windows have replaced the 12 radiators that can be seen behind the work bench.

Under the skylights, units are suspended at ceiling height and placed to deliver air along the length of the skylight to create a general air movement. In the painting department, the pipe coils previously used for heating had been placed somewhat closer to the skylight glass than shown in the repair-shop picture. Due to the great difference between inside and outside temperature, trouble was continuously experienced with cracked glass. When unit heaters were installed this trouble disappeared.

Previous to modernization of the heating system it was impossible to heat any department without having to heat about half of the entire building. When the unit heaters were installed, the main steam piping was rearranged so that the various departments can be supplied with steam as required. There are 10 zones, all controlled from the boiler room by the engineer. Now when the office requires heat we can supply it without having to heat up the rest of the building. Consequently, unnecessary heating of departments not in use does not occur and a great deal of steam previously wasted in this manner is now saved.

Under the old system of direct radiation, we found it necessary to start heating the various departments at about 2:00 A.M. Men report for work at 7:30, and even with this 5½-hr. heating-up period we failed to secure a satisfactory distribution of warmed air. With new system we find we do not have to start heating until 6:30, or only 1 hr. before the men come to work.

The present heating system is much more flexible than the old, and the foreman in each department can

see to it that the room temperature is maintained at 60 deg. Previous to the change-over it was impossible to do so, as most of the radiators were under benches and no one would get under the benches to close the valves. I believe that 90% of the valves on these radiators were never turned off. This is especially true of the blacksmith shop, where a lot of scrap iron is piled under all of the benches in front of the old radiators. In this department we disconnected 36 radiators, 36 valves and traps and installed only two unit heaters with two valves and traps and experienced much better heating.

Steam is supplied by two oil-fired Titus h.r.t. boilers set in battery, each having 1,750 sq.ft. of heating surface. They are operated at about 45 lb. pressure and steam for heating is reduced to 5 to 6 lb. Two other similar boilers with grates are incinerators.

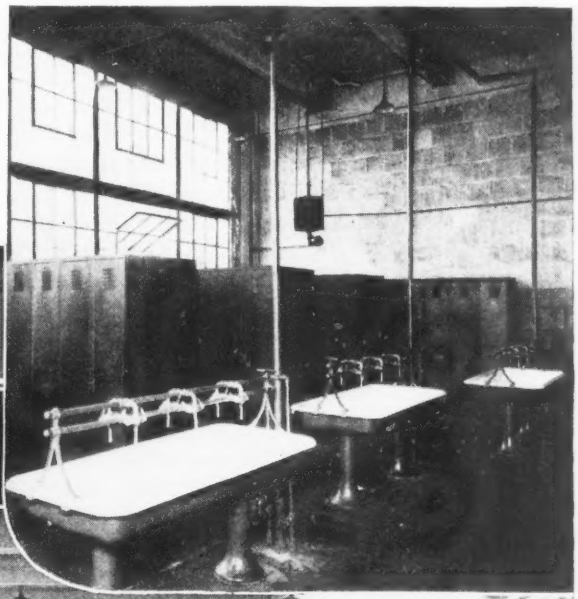
Settings of the two oil-fired boilers were gone over and made air-tight. Automatic air-operated soot blowers were installed which do a better job and take much less time than the old hand method of cleaning tubes. The bridge wall was moved forward somewhat and stack dampers were installed together with thermometer for recording flue-gas temperature.

Before the changes were made, difficulty was experienced in obtaining satisfactory pressure on the heating system at the north end of the building. This was largely overcome by the changes made to the main steam piping in the boiler room. Steam from the boiler was delivered through a reducing valve to a 10-in. header in front of the boiler and from which lines to various parts of the heating system branched. This header was evidently too small, and a new reducing valve was installed and arranged to discharge directly into the large branch main serving the north end of the building.

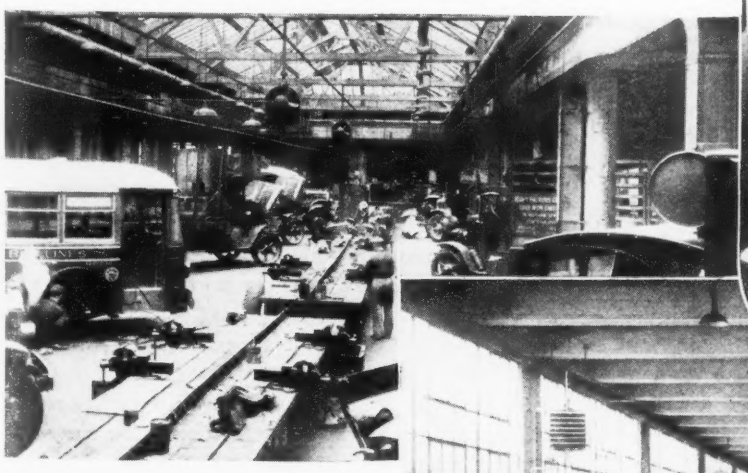
The modernized heating system was placed in operation about the middle of October, 1934. During this month oil consumption was greater than it should have been, as the men in charge were not yet familiar with the proper method of operating the unit-heater system. It seemed that every one wanted to see the units in operation and feel the hot breeze, whether it was necessary or not. This condition was stopped when orders were given to maintain 60 deg. in the shop and 72 deg. in the offices. Thermometers were installed throughout the building so these instructions could be followed.

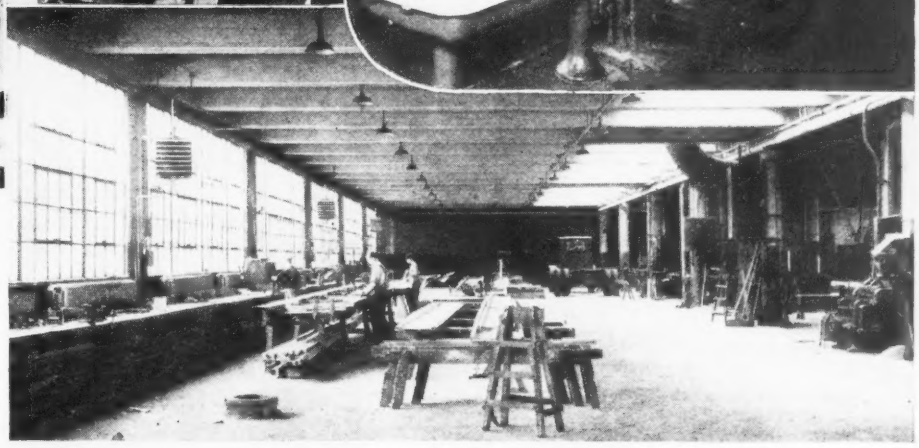
SPRAYED BABBITT—Former difficulties with making genuine babbitt metal wire in gages small enough and with sufficient tensile strength to permit its use in metal-spray guns have now been overcome, and Government Genuine and Diesel Marine grades are now available for spraying. Such a bearing offers several advantages over conventional poured bearings, namely: The journal need only be sandblasted instead of being tinned. Linings as thin as $\frac{1}{16}$ in. may be sprayed in without danger of lifting or peeling. There is little or no danger of blowholes. Anchoring is not required. Government Genuine (high tin-base) babbitt sprayed on has a yield point of 7,700 lb. per sq.in., high enough for any known bearing service. The wire is not brittle and doesn't break during use, and the coating as applied is as regular and can be machined just as a poured coat would be. The process is also being used on diesel engine bearings to replace white brass and similar alloys. Babbitt welding has also been done successfully, and is described in *Power* for October, page 549.

Right—One unit heats the wash room quickly and helps drying by maintaining air movement

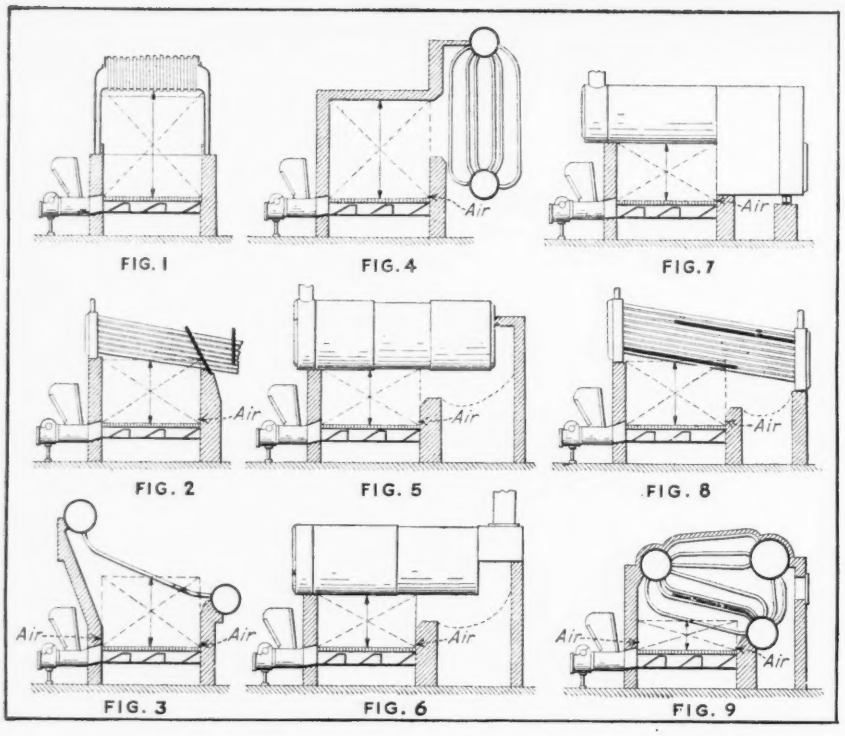


Below—Unit heaters replaced pipe coil around edge of sky light





Right — Unit heaters placed along the windows keep men at work benches comfortable



SAFE

By Hugh R. Carr
Carr-Kuehnle Co.

Smoke elimination is becoming more and more important in city steam plants. Here are results of a study with underfeed - stokered boiler furnaces

INCOMPLETE combustion, the prime cause of smoke, is caused by too short a time allowance for furnace gas in the presence of heat and incomplete mixing of the strata of lean and rich gases produced from varying sections of the fire. The less the mixing, the more burning time required.

Assuming effective mixing, the time of the mixed gases in the furnace depends on the average velocity of the gas leaving the stoker fuel bed and the average length of flame travel from fuel bed to boiler heating surface. The average velocity leaving is approximately proportional to the heat liberated in burning the fuel, but the average length of flame travel varies somewhat with the shape of the furnace.

It is evident that a furnace shaped as a rectangular box is the simplest form, Fig. 1, and the available length of travel is measurable. Any other furnace may contain dead, ineffective corners. For purposes of comparison, I assumed that effective furnace volume, in each case, was equal to the area of the entire stoker (for the bottom of the furnace) multiplied by the average vertical height from top of stoker to heating surface, for convenience taken as the vertical height at the geometrical center of the stoker. With the exceptions as noted later, furnace volume in all cases was measured in this way. This was arbitrary, but evidently is the only way to eliminate variations in judgment as to the relative effectiveness of dead spaces.

Figs. 2 to 4 show the effective limits of the arbitrarily taken effective volume (one side of the rectangle is shown, which multiplied by the width of the stoker gives the volume) for straight-tube, bent-tube, and vertical (all water-tube) boilers respectively. On this basis it was found that the highest-capacity tests averaged in round figures as follows (other tests were not run up to these capacities because they required higher efficiencies):

(a) Average* velocity air entering fuel bed per average foot flame travel, 19 ft. per min.

(b) Average heat liberated per sq.ft. fuel bed per average foot flame travel 90,000 B.t.u. per. hr.

(c) Average velocity calculated leaving the fire at 2,500 deg. F. per average time of one cubic foot of gases in furnace, 106 ft. per min.

(d) Calculated at 2,500 deg. F., average time of a cubic foot of gases in furnace, 1.8 sec.

*Note: All corrected to 50% excess air in gas analysis at boiler outlet.

Except academically, the velocity figures are not of use, since they are necessarily calculated from the fuel burned, as is also the B.t.u. per hr. The latter is the more reliable figure for comparison, since it does not rely on assumptions of allowance for air infiltration through the setting. This air does not go through the fuel bed, but creeps up the walls and appears in the gas analysis at the boiler damper.

Since it has been found that the flue gas per 10,000 B.t.u. liberated is almost exactly the same for all coals (8.1 lb. at zero excess air), B.t.u. liberated is an ideal and easily obtained value to use in comparing furnaces, *i.e.*, maximum design limit of, say, 80,000 B.t.u. per hr. average for each cubic foot of furnace volume directly above the stoker (and a lower value for very high-volatile long-flaming coals). No such heat release, of course, should be expected to be successful without thorough mixing of the gases in the furnace.

Such a design limit provides an even more handy value, *i.e.*, $1\frac{1}{2}$ in. vertical space for each 10,000 B.t.u liberated per hour per sq.ft. of stoker.

Fig. 4—*Vertical watertube boilers* have no heating surface over them, so they may be treated as vertical

FURNACE PROPORTIONS

Prevent Smoke with Underfeed Stokers

baffled straight-tube boilers, but the limiting distance is measured from center of stoker vertically up to arch.

Figs. 5 to 9 show five types of boilers automatically subject to exceptional treatment:

Fig. 5—*HRT boilers:* These have a relatively large combustion space at the rear between the furnace and the entrance to the tubes. It is considered that 35% may safely be added to the "vertical furnace volume" to obtain an equivalent volume comparable to the "vertical volume" used with water-tube boilers.

Fig. 6—*Steel compact-type heating boilers* also have a rear effective combustion space similar to the HRT but not so large. These boilers have also more heating surface in the furnace, thus a cooler furnace to slow up the gas slightly. It is considered also that 35% may safely be added to the "vertical volume" to get a comparable relative value.

Fig. 7—*Firebox boilers* have a slightly cooler furnace but no excess volume. It has been recommended that this fact be recognized by allowing 15%.

Fig. 8—*Horizontally baffled straight-tube boilers* have also rear combustion spaces effective, but not so much as HRT. 15% is a fair figure to add for such installations.

Fig. 9—*Bent-tube boilers* fired from under the mud drum, instead of as conventionally at the front wall, have about the same excess effective furnace volume at the front of the boiler as the horizontal-baffled straight-tube boiler has at the rear.

Since in all cases it seems most convenient to set the design limits to a height dimension rather than a volume relation, all boilers arranged, including the above exceptions, can be converted to measurement from the center of the stoker vertical to the heating surface. The following table summarizes all on that basis:

Corresponds with Fig. No.	Type Boiler With Underfeed Stoker	Inches vertical measurement from center of stoker to heating surface, or arch, per 10,000 B.t.u. liberated per sq. ft. of stokers
	Bent Water-tube	
	a. Fired at front wall	1.5
9	b. Fired at rear wall	1.3
	Straight Water-tube	
	a. Vertically Baffled	1.5
8	b. Horizontally Baffled	1.3
4	Vertical Water-tube	1.5
5	HRT	1.1
6	Steel Compact	1.1
7	Firebox	1.3

New Boiler Plants: The table gives extreme design limits. Good judgment would dictate that around 50% higher settings be used as a safety precaution against future use of long-flame coals.

Gas Mixing: No installation should be made without proper inclusion of overfire air or steam jets at points in the furnace to blow the flame into itself and away from heating surface. Without gas mixing, good judgment would use setting heights based on double the values in the table.

Minimum Heights: Although it is inconceivable that anyone would invest in a stoker for exceptionally low burning rates, it has been suggested that any heat liberation below 30,000 B.t.u. per hr. per average sq.ft. of stoker have the setting height figured on the 30,000 B.t.u. basis.

Peak Capacity: It is essential that settings be high enough properly to account for peak capacities and not exceed the design limits, although a great deal of tolerance from limiting dimensions to account for very short peaks is not economically justified.

Effect of Fuel-Bed Thickness: Fuel-bed thickness was eliminated from the basis of comparison because it is a variable which is practically a constant percentage of the setting height. The thickness decreases with the size of stoker and correspondingly with the setting height, since the smaller the stoker the smaller the maximum coal burned per sq.ft.

Example of Design: 3,000-sq.ft. horizontally baffled straight-tube boiler at maximum capacity (200% rating) has an equivalent evaporation of 20,700 lb. of steam an hour, with stoker 7 ft. wide by 7 feet long, *B.t.u. per sq.ft. of stoker* =

$$\frac{20{,}700 \times 970.4}{7 \times 7 \times \text{assumed efficiency of } 70\%} = 587{,}000$$

This is 59 ten-thousands, approximately.

Minimum setting is 59 x 1.3 = 77 in. from center of stoker to tube surface vertically above.

Preferred setting is 50% more, or 115 in. (9 ft. 7 in.), this being a very high burning rate.

If the stoker had been 7 x 9 ft., the preferred setting would have been 89 in. on account of the lower burning rate and lower velocity of gases.

Border-Line Cases: Where it is not possible on new boiler installations due to physical reasons, such as lack of headroom, to get the full 50% allowance over design limits tabulated above, a study of the actual layout may allow some divergence from the 50% allowance above minimum design.

Advantages of this System are practicality, simplicity, convenience, and the absence of confusion.

TEST YOUR OWN BOILERS—VI

By Walter H. Wood
Combustion Engineering Co., Inc.

Precautions necessary in making flue-gas analyses are explained in this sixth article of the series

AT REGULAR and frequent intervals during a test, samples of gas leaving the boiler (or economizer or air preheater, if either is used), should be analyzed for carbon dioxide (CO_2) oxygen (O_2) and carbon monoxide (CO). The objects of these analyses are:

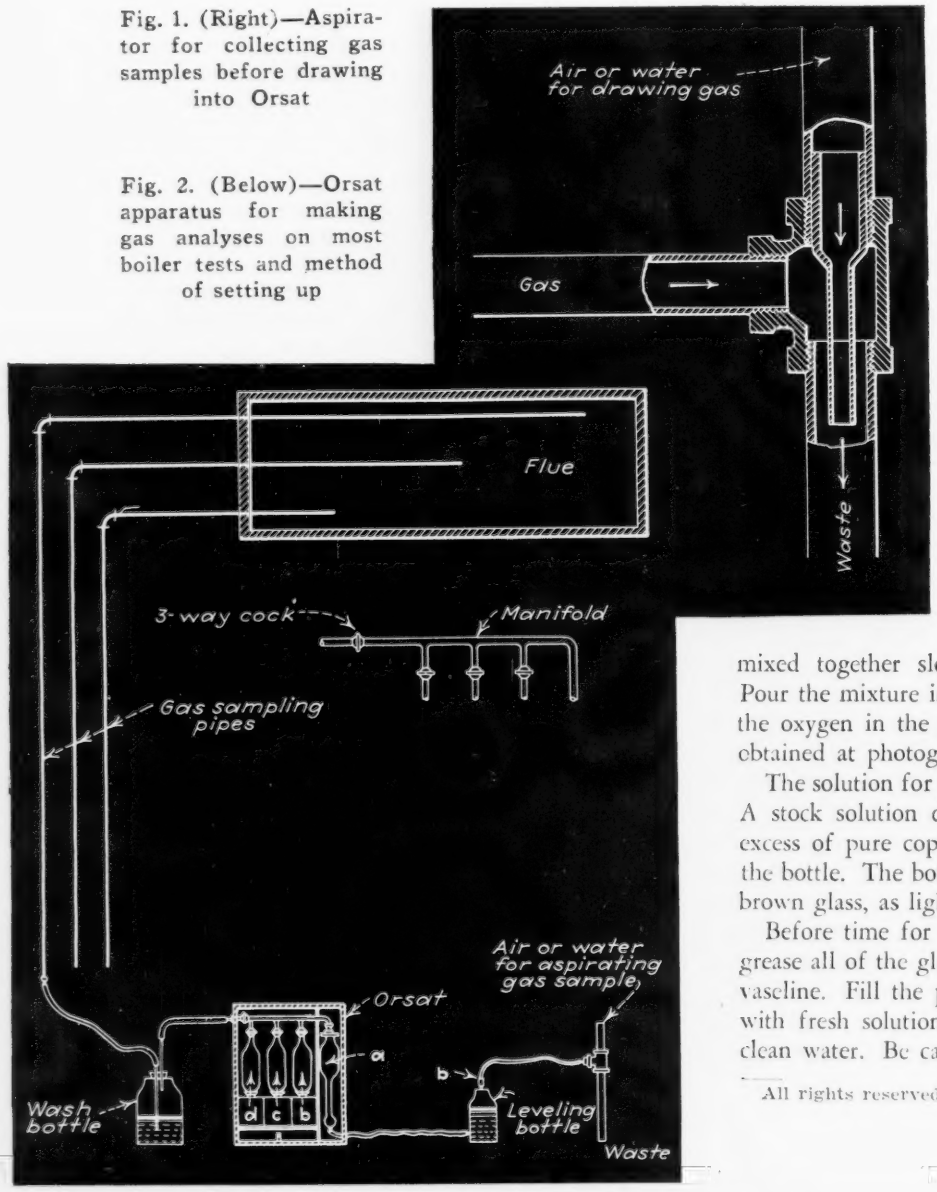
1. To show the operator whether too much or too little air is being supplied for burning the fuel, and
2. To obtain data necessary in calculating one of the principal losses in the heat balance.

Before the test is started, examine the setting carefully and stop all leaks in brickwork and elsewhere about the unit to prevent leakage of air into the setting.

An Orsat is the most convenient apparatus for making gas analyses on most boiler tests. It is illustrated in Fig. 2, which also shows a convenient method of setting up the apparatus. The measuring burette (*a*) is graduated from 0 to 100 and usually has a capacity of 100 cc. or 50 cc. The larger apparatus is somewhat more accurate, while the smaller one is more convenient for carrying. Absorption pipettes *b*, *c* and *d* are filled respectively with solutions of potassium hydroxide, potassium pyrogallate, and cuprous chloride. These solutions can be obtained from chemical supply houses, or from the manufacturers of the apparatus. Solutions for pipettes *b* and *c* are easily made up, if a small balance and glass graduate and beakers are available. A sufficient quantity of potassium-hydroxide solution for the 100-cc. apparatus can be made by mixing 40 grams of potassium hydroxide in 100 cc. of water, or say $3\frac{1}{4}$ oz. potassium in 8 oz. water. The solution heats as the potassium hydroxide dissolves, and for that reason make it in a beaker and allow it to cool, then pour it into pipette *b*. That solution absorbs the carbon dioxide in the gases.

Fig. 1. (Right)—Aspirator for collecting gas samples before drawing into Orsat

Fig. 2. (Below)—Orsat apparatus for making gas analyses on most boiler tests and method of setting up



A good solution for pipette *c* is made by dissolving 120 grams of potassium hydroxide in 80 cc. of water and allowing it to cool. A solution of 15 grams of pyrogallic acid and 5 cc. of water is then made, and the two solutions mixed together slowly to avoid too much heating. Pour the mixture into pipette *c*. This solution absorbs the oxygen in the gases. The pyrogallic acid can be obtained at photographic supply houses.

The solution for pipette *d* is more difficult to prepare. A stock solution can be kept for a long time if an excess of pure copper strips or copper foil is kept in the bottle. The bottles for solutions *c* and *d* should be brown glass, as light affects these solutions.

Before time for starting a test, clean the Orsat and grease all of the glass stopcocks with a light coating of vaseline. Fill the pipettes a little more than half full with fresh solutions, and fill the leveling bottle with clean water. Be careful to keep from drawing any of

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the solutions into the glass manifold above the stopcocks, at any time, otherwise part of the sample of gas will be absorbed when it is first drawn into the apparatus, and the analyses will be in error. If you draw any solution into the manifold accidentally, force water through the manifold from the leveling bottle several times, then empty bottle and refill with clean water.

Draw gas samples from several points at the outlet of the boiler, just before the damper. Fig. 2 shows three locations which usually give satisfactory results. Sampling pipes should be $\frac{1}{8}$-in. or $\frac{1}{4}$-in. iron pipe with fittings made up tight. If copper tubing is used, it should not be of too small bore, otherwise it will get fouled with soot, and drawing the gas samples through will be difficult. Iron collecting pipes should not be used in gas temperatures of 1,000 deg. or over, otherwise the gas drawn into the Orsat may undergo a change which will give incorrect results in analysis. Samples of gas of high temperature should be drawn through water-cooled sampling tubes.

The arrangement for collecting gas samples in Fig. 2 includes an aspirator and a wash bottle for removing any soot or cinders from the gas before it is drawn into the Orsat. The aspirator, shown in detail in Fig. 1, can be made of $\frac{1}{2}$-in. iron or brass pipe. Air or water can be used in the aspirator. A rubber hose is used to connect the gas sampling pipes with a glass tube leading to the bottom of the wash bottle filled about half full of water and fitted with a tight rubber stopper. A short glass tube, reaching just through the rubber stopper, connects the wash bottle with the intake end of the Orsat manifold. One end of a rubber tube is attached to the suction connection of the aspirator. A short piece of glass tube is inserted in the other end of the rubber tube. Friction tape is wound around the glass tube to form a stopper that will fit the mouth of the leveling bottle.

To draw a sample of gas into the Orsat, have the leveling bottle nearly full of water. Turn air or water through the aspirator. Open the 3-way stopcock on the manifold by turning the handle to a horizontal position. Insert the friction-tape stopper into the mouth of the leveling bottle. The aspirator should cause the gas to be drawn through the wash bottle, Orsat manifold and measuring burette, and up through the leveling bottle, to the aspirator. After drawing gas through the system for a minute or two, remove the stopper from the leveling bottle. The Orsat is then filled with gas.

The leveling bottle should be raised until the water flows up into the burette, to make sure that no air is trapped in the leveling-bottle tubing. Then lower the leveling bottle until the water is out of the burette or nearly so, pinch the rubber tubing and close the 3-way cock. A slight pressure should be put on the gas in the burette by raising the leveling bottle. Then gradually open the 3-way cock and bring the water in the burette to zero. Be careful to see that no air is drawn in through the 3-way cock while bringing the level of water in the burette to zero. Then pass the gas into pipette *b* several times, bring the solution back to its proper level in the pipette, and read the burette with the water in the leveling bottle and burette at the same height. The gas should be passed into the same pipette again several times, and the level re-checked to make sure all gas is absorbed.

The same procedure is followed with pipettes *c* and *d*, the readings on the scale of the burette being noted each time. The burette reading after passing the gas into pipette *b* until no change results, is the percentage of CO_2 in the gases. The reading of the burette scale after finishing absorption in pipette *c*, minus the reading from pipette *b*, represents the percentage of O_2 (oxygen) in the gases. The reading from pipette *d*, minus the reading from pipette *c*, is the CO (carbon monoxide) in the gases, in per cent.

Check carefully from time to time to see that there are no leaks anywhere in the Orsat, piping or tubing. The solutions must be kept out of the manifold and the wash bottles. Check readings to make sure that the absorption is complete before passing the gas to the next pipette. Glass stopcocks should be kept greased with vaseline to prevent sticking. If the pipettes are filled with glass tubes, to speed up absorption, examine the pipettes carefully to see that a glass tube is not directly over the neck connecting the two halves of the pipette. When one of the glass tubes extend into the neck, it is difficult to keep the gas from passing down that tube and being lost out through the other leg of the pipette. Rubber-bulb aspirators are furnished with Orsats, for pumping gas samples into the apparatus. If such aspirators are used, the rubber tube connections should be tested for leaks frequently.

DIESEL FUEL & LUBRICATING OIL COSTS

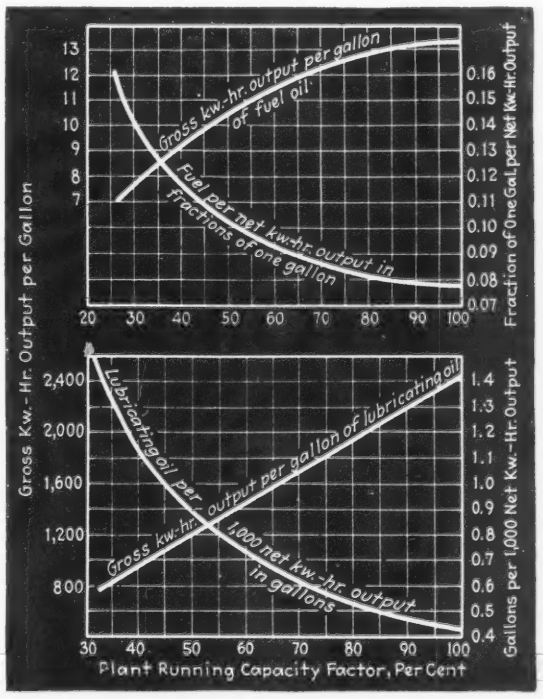

Gross kw.-hr. output per gallon of fuel oil
Fuel per net kw.-hr. output in fractions of one gallon
Gross Kw.-Hr. Output per Gallon
Fraction of One Gal. per Net Kw.-Hr. Output
Lubricating oil per gross kw.-hr. output per gallon of lubricating oil
1,000 net kw.-hr. output in gallons
Gallons per 1,000 Net Kw.-Hr. Output
Plant Running Capacity Factor, Per Cent

FIG. 1 (top) gives fuel economy for modern diesel plants and is based midway between median and best-consumption curves taken from the 1933 A.S.M.E. Power Cost Sub-Committee report on 122 plants. (These curves contain very old plants as well as newer ones, hence the raised basis for this curve. Actually, this curve coincides exactly with the median curve for all solid-injection engines in the original curves.) For ease of use, another curve is superimposed, giving fuel consumption in fractions of a gallon per net kw.-hr., assuming 5% of gross generation consumed by auxiliaries at an average load of 60%. Average plant running capacity factor is 58%; a fairly high figure for central station-type plants is 75%; industrial plants can hit the 80's. **Fig. 2** (below) is similarly prepared for lubricating-oil consumption. These curves are abstracted from the forthcoming "Standard Practices" of the D.E.M.A. See pages 592 and 593 of this number for particulars and one use of these curves.

SPEAKING OF POWER

● ST. CROIX PAPER COMPANY, up in Maine, has operated 3,000,000 man-hours since Sept. 21, 1931, without a single lost-time accident. You'll find the story on page 570. . . . It seems nothing short of a miracle that a mill can employ an average of 400 men for four years straight without somebody breaking a leg or losing a finger. . . . Naturally you look for good management everywhere in such a mill, and you certainly find it in the St. Croix power plant. Since 1923, continued modernization of operation and equipment has cut steam costs from 83 cents per thousand to 36 cents. . . . Lower steam cost—fewer accidents. Here are two hall-marks of good management.

Speaking of St. Croix, you will be interested in their method of storing heat for week-end use. Small loads on big boilers don't work out economically, and so it used to take 100 tons of coal to keep up pressure and supply heating steam on Saturday and Sunday. . . . Now it's done with 30 tons burned during the week. Byproduct power generated for 4,000 B.t.u. from this additional steam displaces 200,000 kw.-hr. of hydro power and leaves the equivalent water to store up during the week. On Saturday and Sunday this accumulated energy is switched into an electric boiler, while the pulverized-fuel boilers are completely shut down. . . . Net result 70 tons of coal saved every week and another example of shrewd management!

The recent death of Oscar Junggren, General Electric's genius of turbine design, removes another creative engineer from our midst. . . . His monuments, as they view it in Schenectady, are not merely the thirty new turbine designs he created in the eight years from 1924 to 1932, but more significantly the billions of kilowatt-hours they have produced and will produce. It is said that fully one-half of the electric power developed in the world today is generated by the brain children of Oscar Junggren. . . . What better memorial could any man ask?

While in Chicago for a week of plant visits—with considerable competition from the World series, as well as the Welding Society convention and the Metal show—I managed to steal away for one short day in good old Milwaukee. . . . While there I had the pleasure of inspecting an ultra-modern malt plant from stem to stern. Wonderful layout, typical of the newest process plants in all fields. The power house was old, having served the parent of the present establishment, yet here too modernization was in the air and a complete revamping in progress. In another year or two the place will be all set for low power-service cost per unit of malt (whatever that is). . . . The formula here, as everywhere else, is low unit cost of the power services plus low consumption per unit of manufactured product. Power-plant design and operation gives you the first, transmission and application engineering the second. . . . And the two together always spell profits and dividends.

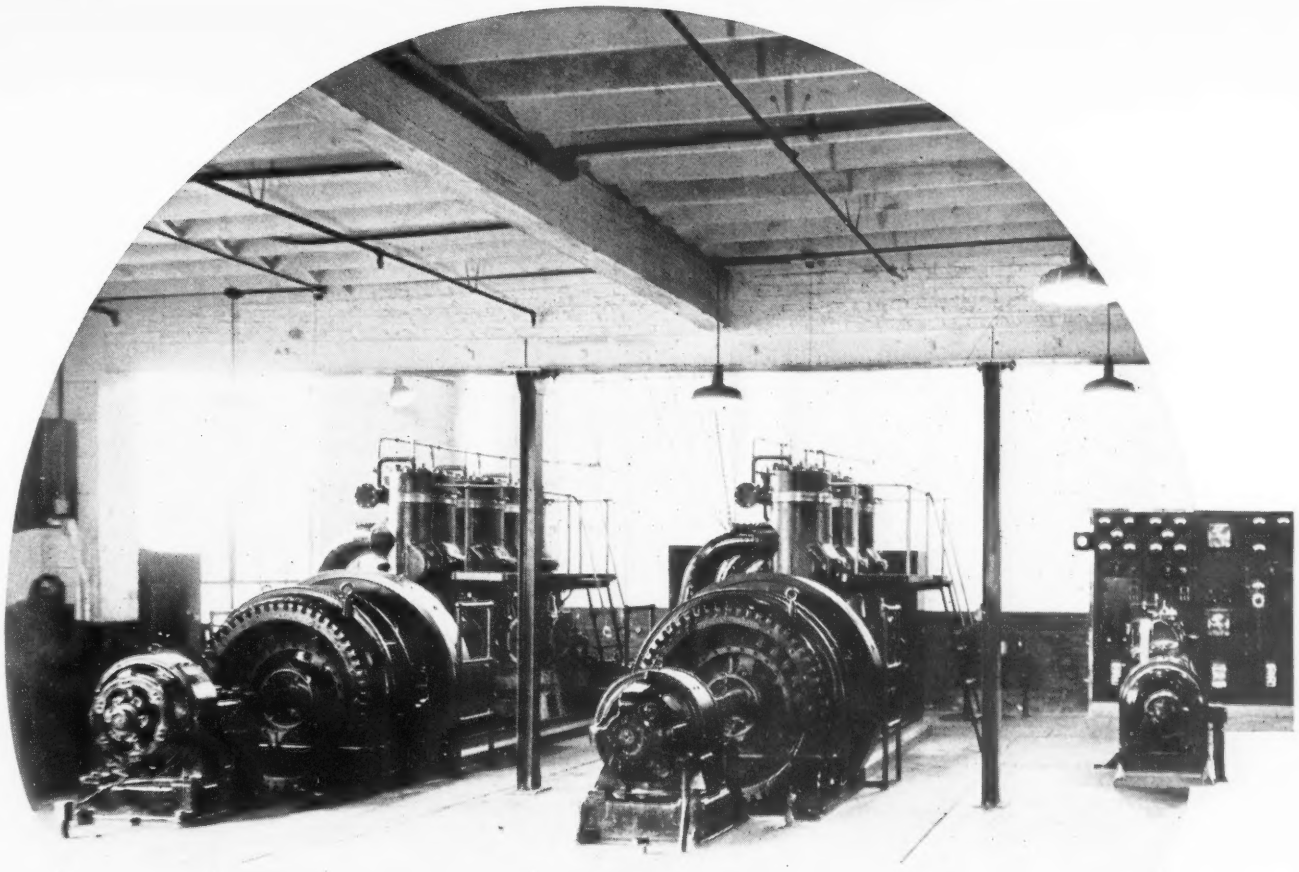
One fact I can now report without any "ifs" or "buts": Business has stopped crawling and started to walk. No matter where I go, or who I talk to, I find it gaining speed week after week. . . . Such improvement shows up first in increased sales and better profits. The unemployed are the last to notice it, because employers naturally try to swing their increasing business for a while with existing staffs. . . . But this can't go on forever, and employment is now beginning to feed on this new stream of nourishment. Last month I mentioned the existing shortage of skilled machinists. Now I am glad to report the first-hand observation that professionally trained engineers are again being sought after, at least in Chicago.

Just a few days ago I had an interesting conversation with Prof. Hermann Bleibtreu of the Darmstadt (Germany) Technische Hochschule. He made the comment that engineering thinking in Germany is swinging strongly in the direction of simpler and less costly power plants, even at some slight sacrifice in efficiency. . . . For example, said Prof. Bleibtreu, German boiler manufacturers are turning away from some of the more complex designs to simple two-drum and even one-drum boilers. It is practicable in Germany today, he told me, to build a complete steam station of about 30,000 kw. for about 135 marks ($53 at present exchange) per kilowatt. The design to make this possible has already been worked out on paper and involves some radical departures from current practice. He also told me that, in Germany at least, a high-pressure station costs no more, and sometimes less, than a low-pressure. . . . German engineers are showing a great interest in small boilers (mostly internally fired) for industrial plants, and several new types have been developed.

In my travels I frequently meet the operating engineer who tells me, "I have no plant—I buy my current." This man has boilers, stokers, pulverizers, feedwater heaters, coal and ash handling equipment, air compressors, pumps, refrigerating machines, elevators, heating and ventilating systems, perhaps air conditioning also—at least 80% of the equipment found in a complete power-service setup. Still he has no "plant." What's in a name?

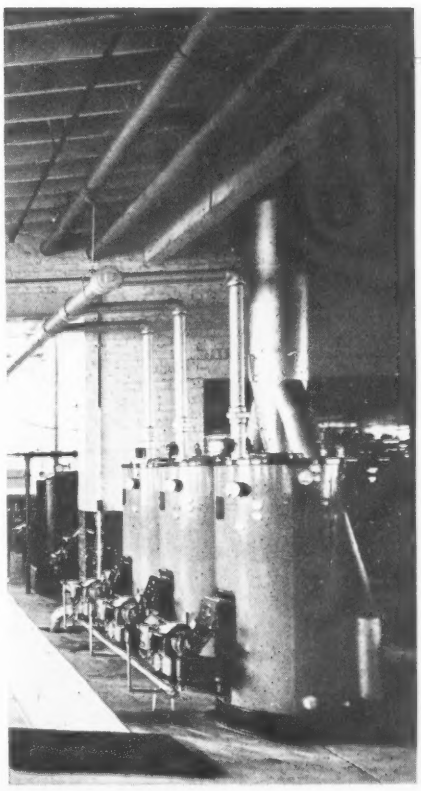
An Illinois newspaper reports stalling of diesel locomotives from "carburetor trouble." First thing you know these reporters will be checking up on the ignition system. . . . No telling where trouble is likely to be localized by the doctors of the non-technical press.

PHIL SWAIN
Editor



CHEAP SHOP HEAT FROM DIESELS

EFFECTIVE utilization of the heat in diesel jacket water makes it possible for Rockford Screw Products Co., Rockford, Ill., to heat its shop for almost nothing. Plant power equipment includes two 210-hp., and a 60-hp., 6-cyl., diesel-generator sets, all Fairbanks-Morse units. The first unit was installed in 1932 when the plant was new, the second in 1933 to meet increasing load. Since the plant operates three 8-hr. shifts, load factor is excellent. With both large engines operating at their peak, slightly over 1,000,000 B.t.u. are available in cooling water. This heat is recovered in six unit heaters disposed around the 1-story, glass-walled factory, each with motor-driven fan and two sets of thermostatically operated louvers, one opening outside, one into the plant. Since the heaters serve to cool engine water as well as heat the plant, the fans operate continuously, excess heated air being bypassed outside the building. The thermostats are set for 68-70 deg., and held that temperature all last winter. On Sunday the three small oil-fired hot-water boilers at right take care of necessary heating, while the 60-hp. diesel supplies power. Operating cost of the plant is less than $0.005 per kw.-hr. without credit for heat.



TITANIUM PIGMENT CO.
Sayreville, N. J.
FORD, BACON & DAVIS, ENGINEERS
Two 125,000 lbs. hr. Riley Steam Generating Units—443 lbs. Pressure —637° F. Steam—85% Efficiency

Titanium Pigment also Swings to RILEY

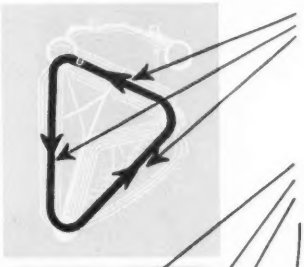
Titanium Pigment selected Riley Units

Under a single responsibility contract
Riley furnishing and installing Riley Boilers
Riley Superheaters
Riley Water-cooled Furnaces
Riley Air Heaters
Riley Steel Clad Insulated Settings
Riley Pulverizers and Feeders
Riley Burners
Riley Flue Gas Scrubbers

because these distinctive characteristics of Riley Steam Generating Units assure outstanding performance - - low steam cost - - absolute reliability

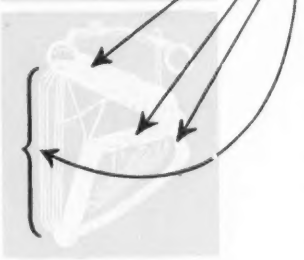
The design of the Riley Boiler is based on the Ring Flow Unidirectional principle of circulation

Minimum Resistance to Circulation



The large areas provided through boiler tube banks reduce resistance to circulation to a minimum.

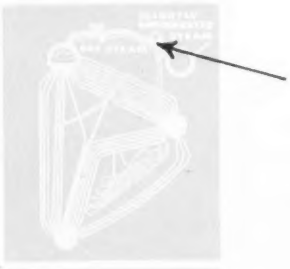
Maximum Force Producing Circulation



All tubes exposed to high temperatures carry upward flow of water and steam bubbles. This directional effect, together with the large head producing flow, insures rapid, positive circulation in a fixed direction in all of the tubes, with a very definitely increasing rate of circulation as the steam output increases.

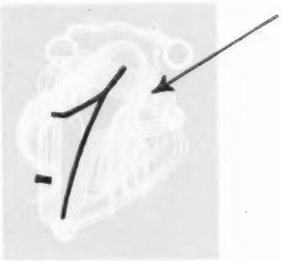
The rapid circulation resulting from the above design characteristics immediately removes all steam bubbles as formed, insuring proper intimate contact between water and tubes which, together with gas baffling for the most effective heat transfer, results in low flue gas temperatures.

Dry, Slightly Superheated Steam



Overcomer tubes connecting the third and fourth drums entirely remove the slight residual moisture from the steam and deliver it dry and superheated 10 to 20 degrees F. to the fourth drum.

Cross Flow of Gases over Heating Surfaces



Riley Boilers are baffled so as to obtain cross flow of gases over the heating surfaces with most effective heat transfer resulting. Baffling is so arranged and gas passages so proportioned as to result in unusually low draft losses. Careful consideration is also given to provision for easy access for inspection.

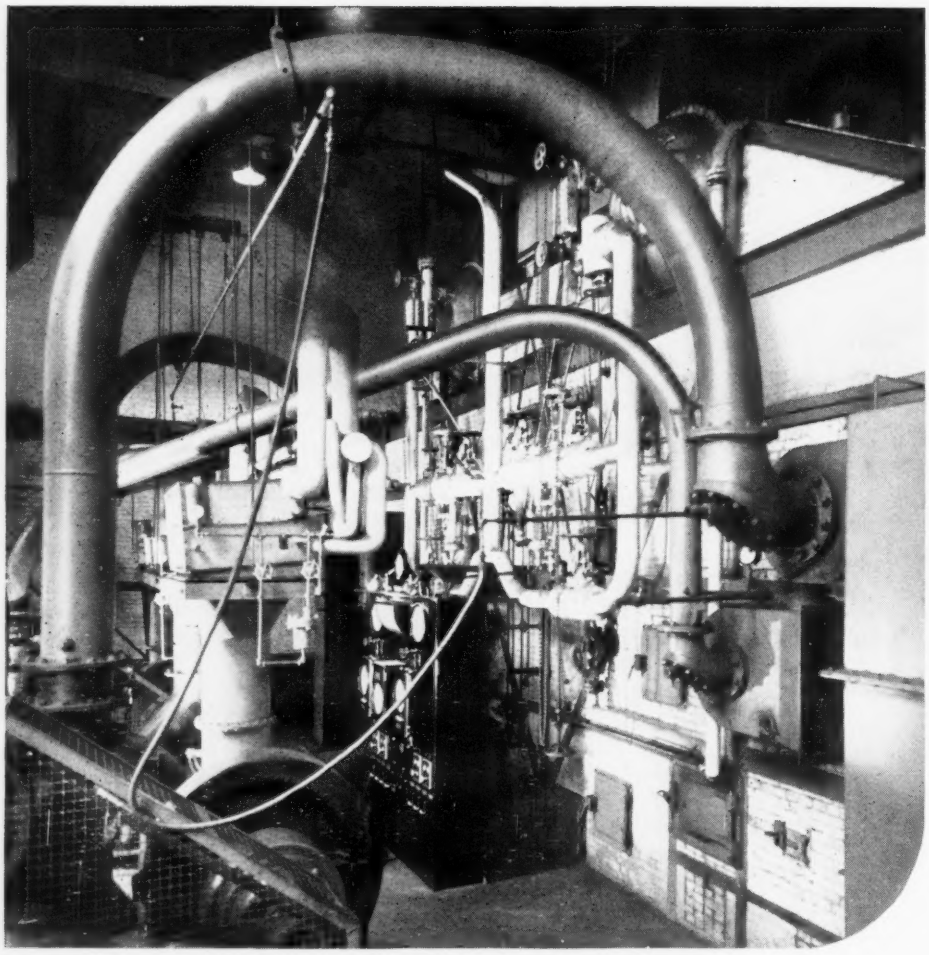
In addition to the above, and other distinctive features of design, you are assured, when purchasing Riley Steam Generating Equipment, of the highest quality materials and workmanship both in manufacture and erection. Unusual satisfaction, high efficiency continuity of operation, and low maintenance result from these plus values. A visit to some of the recent installations of Riley Steam Generating Units will make these plus values perfectly apparent to you. One-eighth-inch scale drawings of recent Riley installations will be gladly sent you upon request.

RILEY STOKER CORPORATION
WORCESTER, MASS.

BOSTON NEW YORK PHILADELPHIA PITTSBURGH BUFFALO CLEVELAND DETROIT TACOMA
ST. LOUIS CINCINNATI CHICAGO ST. PAUL KANSAS CITY LOS ANGELES INDIANAPOLIS ATLANTA

COMPLETE STEAM GENERATING UNITS

BOILERS - PULVERIZERS - BURNERS - STOKERS - SUPERHEATERS - AIR HEATERS
ECONOMIZERS-WATER-COOLED FURNACES-STEEL-CLAD SETTINGS-FLUE GAS SCRUBBERS



Two pulverizers serve the two 40,000-lb. per-hr. integral-furnace boilers generating steam at 400 lb. and 725 deg.

SPOTLESS DIXIE PLANT

By Philip W. Swain

Editor of POWER

IN THE minds of some northerners the South is associated mainly with magnolias, mountaineers, moonlight, cotton, mint julep and plantations. All these things are there aplenty—the regular story-book stuff—but they are merely half the picture. The other half is that of a vast empire stirring with industrial life. In the great textile and tobacco processing areas of the Carolinas, particularly, you find a factory hidden behind every clump of pine trees. And, as often as not, you find this factory equipped with modern machinery, expertly manned.

My recent 2,700-mile automobile tour from Charleston to New York was an eye-opener because I had not been well acquainted with the South. I came back sold on the South in general and on southern industry in particular.

As a sample of something really fine, let me present the power plant of Clinton Cotton Mills, Clinton, S. C. It has already been described (*Power,* September, 1934) but the pictures here shown were the first made after broom and paint brush had removed the last trace of construction debris.

In the absence of Supt. Ed Hill, J. J. West, master mechanic, gave me time and help without stint, while I trailed photo equipment through his spotless establishment, asked questions about operation and crawled inside a furnace shut down for inspection. Looking back at it all I give this plant a rating of 99%. The 1% is knocked off because there is no meter on steam bled to process. Aside from that one item, the simple word "perfect" is the easiest way to describe this plant. Never in your life will you see a more clean-cut engineering job.

Those interested in the details may turn back to the table of equipment in the September, 1934, number. Main features are two very modern 40,000-lb.-per-hr. integral-furnace boilers, pulverized-coal fired and generating steam at 400 lb. and 725 deg. F. Also one 5,000-kw. condensing turbine, bled to process, and another 1,000-kw. condensing turbine for light loads.

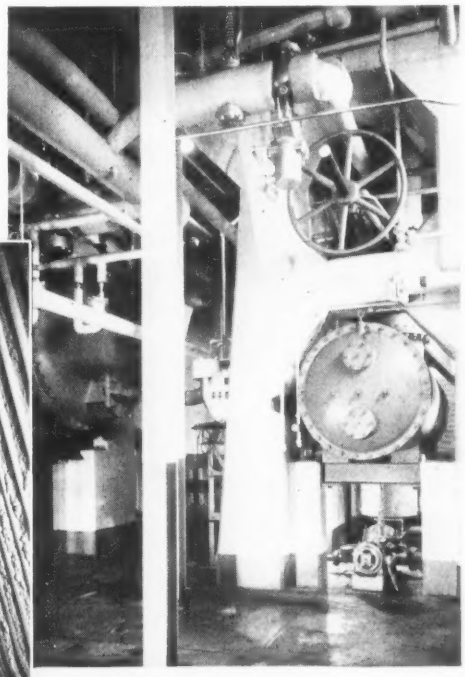
Other points include a deaërating open heater, a high-pressure enclosed heater, an evaporator for make-up, a coal-storage silo.

I have made it plain enough that the plant is neat and clean looking almost beyond belief, but the hard-boiled engineer reader may ask "how does she work?" The answer to this question is equally satisfactory. Without taking any credit for steam bled to process (about 15% of total generated) the plant has averaged 1.3 lbs. of coal per kw.-hr. for the 12 months ending September 30, 1935. This certainly points the way to low-cost industrial power generation in many mills and factories where opportunities for byproduct power are limited.

The coal, of course, is exceptionally good. The plant burns Clinchfield Fuel Co. "Moss" ($\frac{5}{8}$ in. and less) from Dickinson City, Va. The heat value is 14,380 B.t.u. per lb. dry. Moisture runs $2\frac{1}{2}$ to 3%, ash fusion temperature is high, 2,750 deg. F., volatile about 30%. In typical operation, CO_2 is maintained at about 14%.

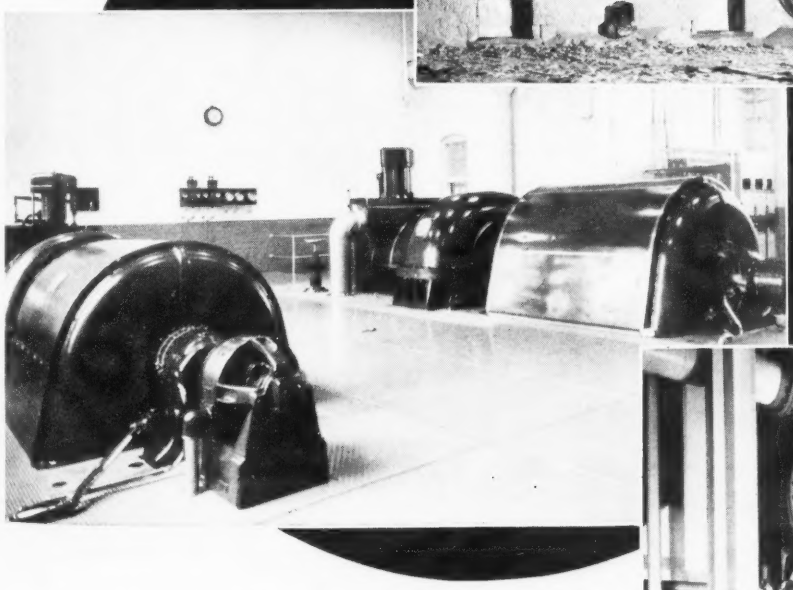
The new type of low-headroom, integral-furnace boiler installed has given excellent results. The furnace, as I inspected it after a year's operation, was in perfect condition (see photo) and I checked again last month that no trouble has been experienced with the boiler or with the pulverized-coal firing. Mr. West estimates that the balls in the pulverizer should be good for three or four years' life at the present rate of wear.

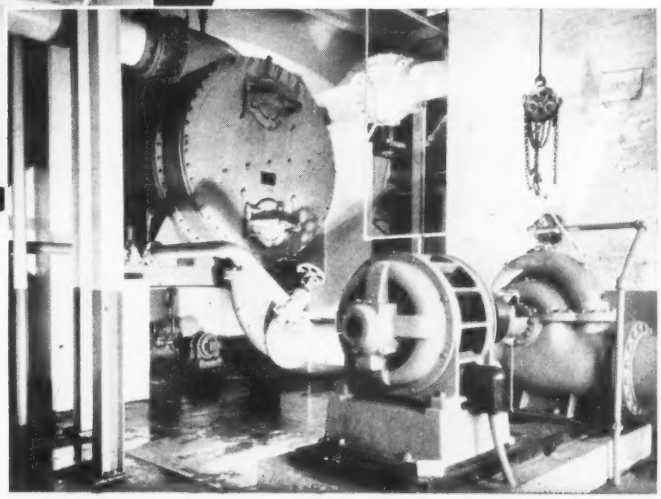
As a standby against possible shut-off of coal supply, fuel-oil standby has been installed. Diesel oil (requiring no preheating) can be pumped directly into the present pulverized-coal burner, the oil being forced through flexible metal hose by a pump with dual drive (gasoline engine and motor).



Furnace refractories were perfect after a year's operation with pulverized coal

The 1,295-sq.ft. surface condenser shown above serves 1,000-kw. turbine





Above is the spotless turbine room with 5,000-kw. turbine in background. This is served by the 6,400-sq.ft. condenser shown at right

PROOF of LOW UPKEEP COST!

For nearly 25 years Armstrong traps have been setting a high standard for economy in maintenance. The basic design and the quality of materials and workmanship minimized the need for repairs and about the only replacements were valves and seats. Records of various Armstrong customers show as much as 90% of all maintenance cost represented by such replacements.

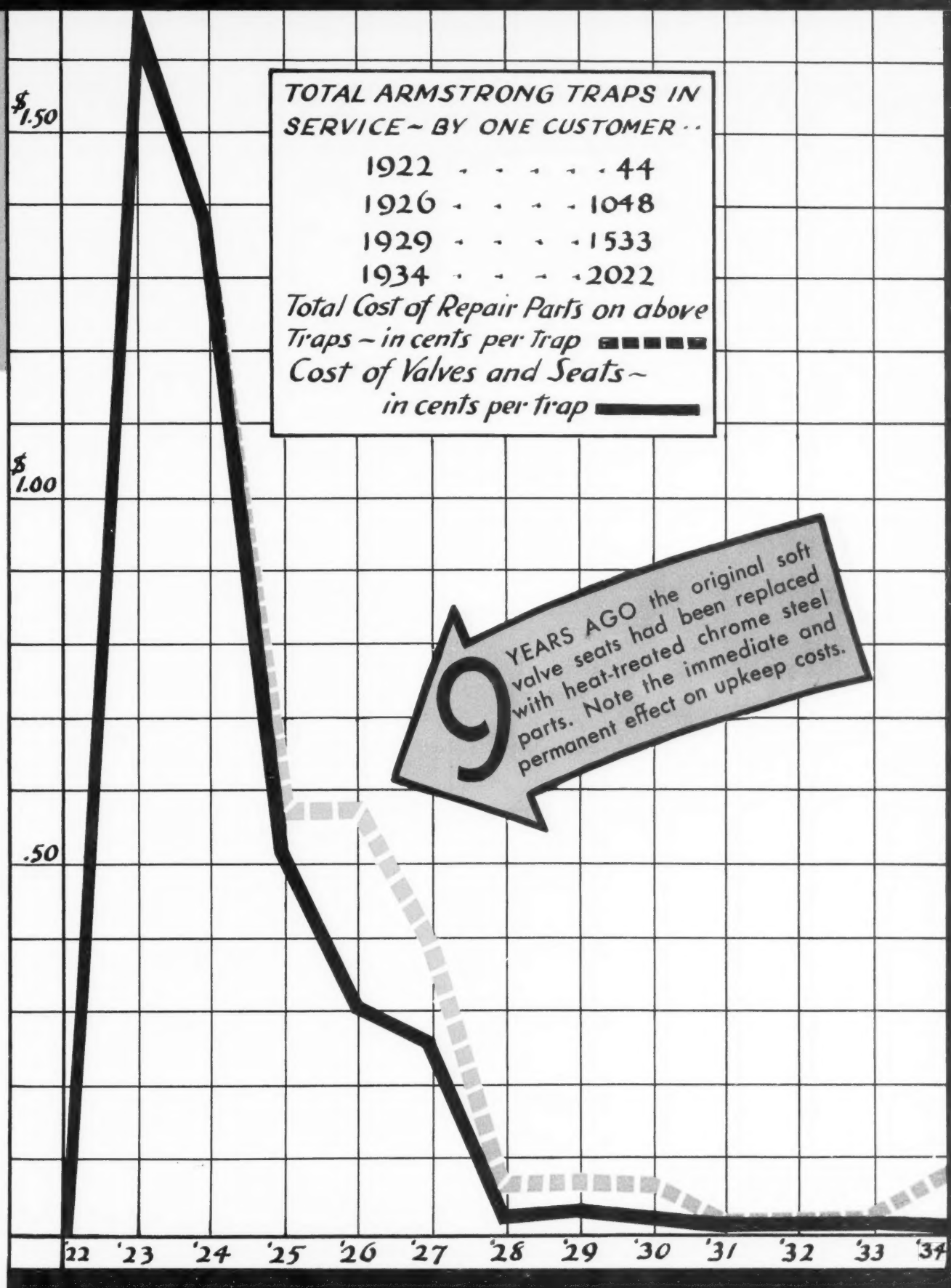
While Armstrong valve parts have always been made of the best available metal, there has been a striking improvement in this direction in the past decade. Phosphor bronze valves used to be considered good—and thousands of Armstrong traps so equipped gave fine records of trouble-free service. But under some conditions bronze would wear rapidly. Special alloys were better but not good enough for Armstrong. By constantly experimenting with heat treatment of chrome steel for the past 12 years, the present standard valve parts were developed. They have no fancy name but their uniform hardness and toughness makes them highly resistant to wear and corrosion. Their close approach to the ideal for long, hard service is best shown by facts and figures.

The chart on the opposite page represents the actual maintenance costs on Armstrong traps for one typical large user. This is clear proof of the economy and dependability of Armstrong traps. We still offer our original 90-day free trial of as many Armstrong traps as you want to test.

ARMSTRONG MACHINE WORKS

812 Maple Street **Three Rivers, Michigan**

ARMSTRONG STEAM TRAPS

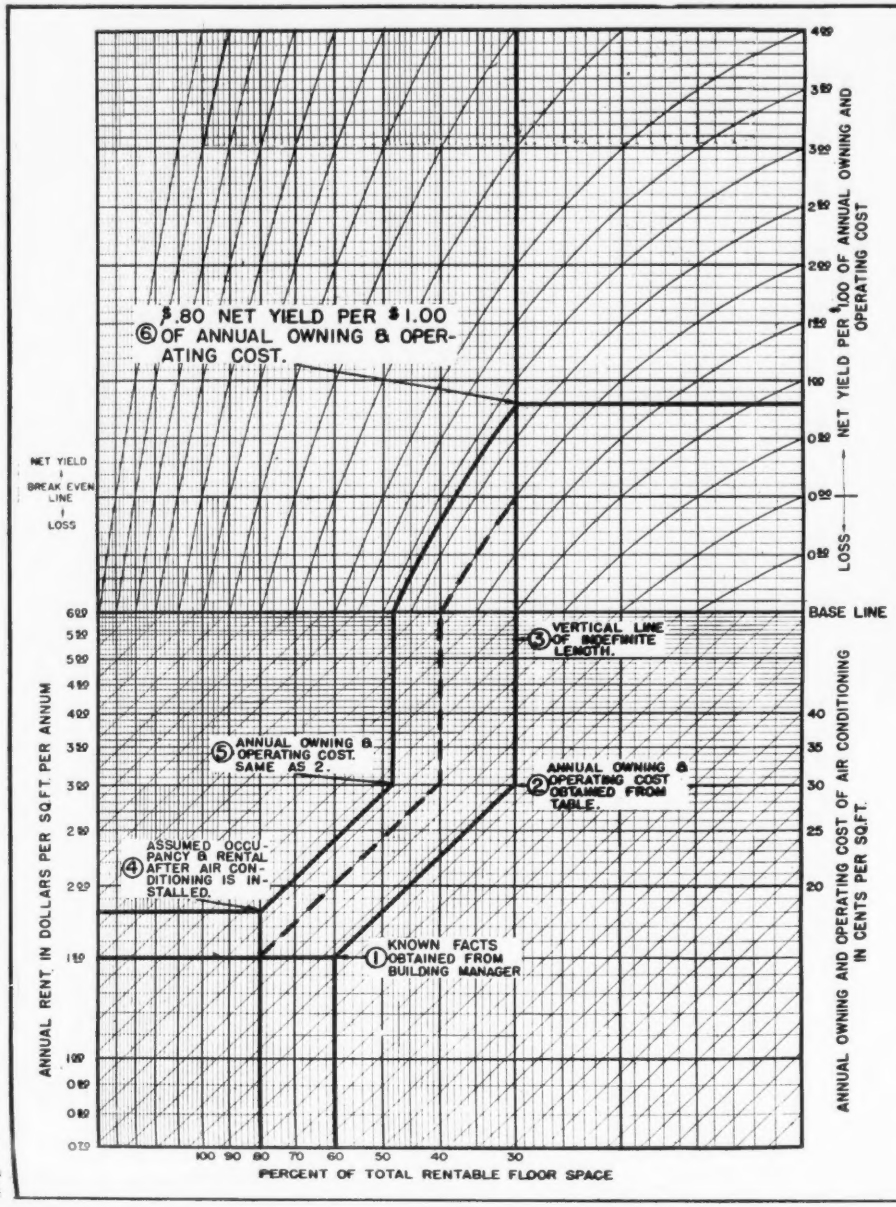

TOTAL ARMSTRONG TRAPS IN SERVICE ~ BY ONE CUSTOMER ··
1922 - - - - - 44
1926 - - - - 1048
1929 - - - - 1533
1934 - - - - 2022
Total Cost of Repair Parts on above Traps ~ in cents per Trap
Cost of Valves and Seats ~ in cents per trap
$1.50
$1.00
.50
9 YEARS AGO the original soft valve seats had been replaced with heat-treated chrome steel parts. Note the immediate and permanent effect on upkeep costs.
'22 '23 '24 '25 '26 '27 '28 '29 '30 '31 '32 '33 '34

The chart above is based on more than 16,500 trap years of service for a single user. The average cost of valves and seats per trap per year for the 13 year period is 15.2 cents and the average cost of all repair parts is 19.4 cents. But the real significance of this chart lies in the decreased costs after the change-over to heat-treated valve parts had been made. The cost per trap per year (from 1928-1934 inclusive) dropped to 3.7 cents for valves and seats and to 4.8 cents for total repair parts. No wonder Armstrong users say you can install these traps and forget them.

© POWER

Chart for Determining Investment Return on Air Conditioning

For buildings averaging more than 10,000 sq.ft. of rentable floor space per floor. For buildings averaging 7,000 to 10,000 increase floor space 10%


$.80 NET YIELD PER $1.00 OF ANNUAL OWNING & OPERATING COST.
NET YIELD
BREAK EVEN LINE
LOSS
BASE LINE
LOSS — NET YIELD PER $1.00 OF ANNUAL OWNING AND OPERATING COST
VERTICAL LINE OF INDEFINITE LENGTH.
ANNUAL OWNING & OPERATING COST. SAME AS 2.
ANNUAL OWNING & OPERATING COST OBTAINED FROM TABLE.
ASSUMED OCCUPANCY & RENTAL AFTER AIR CONDITIONING IS INSTALLED.
KNOWN FACTS OBTAINED FROM BUILDING MANAGER
ANNUAL RENT IN DOLLARS PER SQ.FT. PER ANNUM
ANNUAL OWNING AND OPERATING COST OF AIR CONDITIONING IN CENTS PER SQ.FT.
100 90 80 70 60 50 40 30
PERCENT OF TOTAL RENTABLE FLOOR SPACE

Zone		1	2	3	4
Hours of Refrigeration		1000	1200	1500	1700
Typical Cities		Los Angeles	New York Philadelphia Chicago	Cincinnati Memphis St. Louis	Dallas New Orleans Houston
Building Shape					
	Power	2.3	2.5	3.6	6.2
	Water	.8	.9	1.3	2.2
	Misc.	5.6	5.6	5.6	5.6
	Operating	8.7	9.0	10.5	14.0
	Capital	11.2	12.5	12.5	12.5
	Total	19.9	21.5	23.0	26.5
	Power	2.4	2.7	3.7	6.6
	Water	.9	1.0	1.5	2.5
	Misc.	5.7	5.7	5.7	5.7
	Operating	9.0	9.4	10.9	14.8
	Capital	11.7	13.0	13.0	13.0
	Total	20.7	22.4	23.9	27.8
	Power	2.6	2.9	4.2	7.2
	Water	.9	1.0	1.5	2.5
	Misc.	6.2	6.2	6.2	6.2
	Operating	9.7	10.1	11.9	15.9
	Capital	12.6	14.0	14.0	14.0
	Total	22.3	24.1	25.9	29.9
	Power	2.8	3.1	4.5	7.7
	Water	1.0	1.1	1.6	2.7
	Misc.	6.2	6.2	6.2	6.2
	Operating	10.0	10.4	12.3	16.6
	Capital	14.0	15.5	15.5	15.5
	Total	24.0	25.9	27.8	32.1
	Power	2.9	3.3	4.7	8.0
	Water	1.1	1.2	1.7	3.0
	Misc.	6.3	6.3	6.3	6.3
	Operating	10.3	10.8	12.7	17.3
	Capital	14.4	16.0	16.0	16.0
	Total	24.7	26.8	28.7	33.3

GROSS COSTS IN CENTS PER YEAR PER SQ.FT. OF RENTABLE AREA

NOTES—Based on Depreciation 15 yr., Interest 6%, Power cost $0.01 per kw.-hr., water cost $1 per 1,000 cu.ft. For other power or water rates, correct in direct proportion. Add for roof effect: 20% for 5 stories, 16% for 6 stories, 12% for 8 stories, 10% for 10 stories, 0% for more than 10. Divide a terraced building into separate sections.

WILL it pay to install air conditioning? How much additional space must be rented or what increase in rental must be charged to break even?

Example—What increase in occupancy is necessary to break even if air conditioning is installed in a U-shaped building 10 stories high having a floor area of 150,000 sq.ft. located in Los Angeles. Power costs 1.8¢ per kw.-hr., water costs $2.00 per 1,000 cu.ft. 60% occupancy at rental rate of $1.50. From table of costs, corrected power cost is 5.1 cents, water 2.0 cents per sq.ft. per year. Add 10% for roof effect making total cost 30 cents per sq.ft. per year. Enter chart at 60% occupancy; follow vertically to intersect with present rental of $1.50. Follow diagonally to total operating and owning cost of 30 cents, then vertically to "break even" line. From intersection follow curved line to base line, then vertically down to intersect 30-cent owning and operating cost line. From this point follow diagonal to rental rate line and read required occupancy of 80% to break even. If rental were increased to $1.70, as shown, installation will yield 80 cents per $1. Annual return is 150,000 x 0.30 x 0.80 = $36,000.

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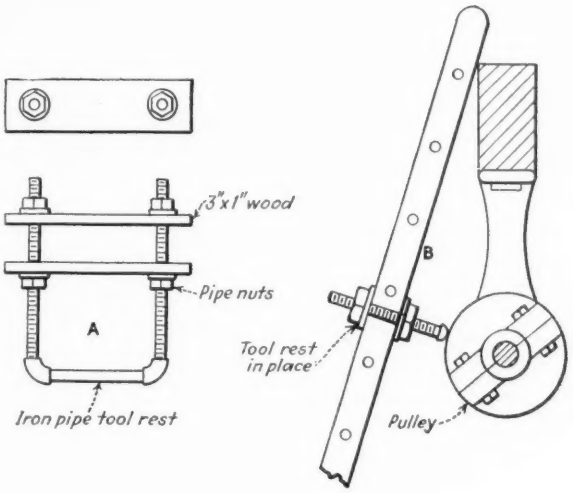
PRACTICAL AIDS TO OPERATION



Ladder Tool Rest for Refacing Pulleys

WOOD split pulleys sometimes warp and get out of round sufficiently to cause serious flapping of belts. In one plant where this occurred it was decided to true the pulleys in place on the shaft. The tool rest was made from two pieces of 1- x 3-in. board and three pieces of $\frac{3}{4}$-in. pipe with fittings, as in the figure. Two pieces of the pipe were threaded full length and passed through holes in the boards. Nuts on these sections clamp the rest to the ladder placed near the pulley. The assembly of the rest is shown at *A*, and how it is mounted on the ladder near the pulley is indicated at *B*. The tool rest is very handy, as it can be moved up or down the ladder and adjusted in or out to suit the size of the pulley and ladder position. A turning tool was made from a flat file and the job done satisfactorily.

Hamilton, Ont. H. MOORE.

Coating Eliminates Tank Sweating

THERE is a preparation used quite commonly on marine condensers which will serve excellently in preventing tank sweating in stationary plants. It consists of a base coat of varnish with granulated cork thrown on.

The primary requirement is a very clean tank, particularly if oil paints were previously used. Then a mixture of 1 gal. linseed, 1 gal. color varnish, 1 qt. Japan drier, 1 gal. quick-drying (2-hr.) varnish and 25 lb. Kalsomine is mixed to the consistency of a good stippling paint. This will cover 1,200 sq.ft. with one coat. It is painted on a small area at a time, then ground cork is thrown against it to cover fairly thoroughly. About 30 lb. of granulated cork is required for 1,200 sq.ft.

If the cork tends to discolor, an outer coat of the same mix can be put over the cork. Any desired color can be used, and the coating will last for several years, meanwhile eliminating sweating entirely.

New York, N. Y. WM. BOHLINGER,
Chief Engineer, Canadian Pacific Bldg.

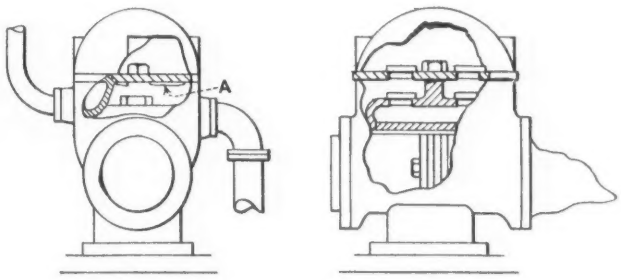
Stationary Air Compressor Made Portable

WE HAVE a 4.5- x 4-in. air compressor connected to a motor by a belt. This compressor was located in the pump room and used to supply air to a fire tank. It was decided if the compressor were made portable it could be moved about the plant and used for several purposes.

To do this part of a broken diving board was bolted to a truck and the compressor with its motor and starting equipment were mounted on it. On the discharge of the compressor, we connected 50 ft. of $\frac{3}{8}$-in. heavy hose, and on the electric end attached a 30-ft. extension cord, good for 30 amp. This gives about 75 ft. working radius from the power source to where the air is used.

The supply line from the fire tank was extended to a convenient location for the portable compressor, so that this service is readily taken care of when required. The compressor is now used in all parts of the plant for cleaning motors and other purposes and has proven very useful.

Chicago, Ill. ABE ROCKLIN.



Finds Cause of Pump Having Low Capacity

SEVERAL years ago I was sent to take charge of a plant that had seven h.r.t. boilers. Feedwater was supplied by two injectors and two simplex pumps. The pumps were identical on the water ends, but one was direct steam-driven and the other through gearing and speed-changing cones. The direct-driven pump would supply water to the seven boilers, but the gear-driven pump could handle only two.

Inquiry revealed that the capacity of the gear pump began to decrease about five years before I came to the plant and that several efforts to locate the cause had failed. I then decided to see what I could do. When the pump was dismantled the piston-packing and valves were found in good condition and nothing was apparent that would indicate a reason for low capacity.

Once when taking the pump apart, we injured the bottom gasket in the discharge deck. When this gasket was removed we discovered that the partition between the two ends of the pump was badly scored at the top, as at *A*. We drilled this section and cut a dovetail, filled the defect with babbitt, which was then scraped to a true surface. When the pump was assembled and put into service again, it developed normal capacity.

New York, N. Y. C. W. PETERS.

Operates Fuel-Oil Valve From Damper Regulator

SEVERAL commercial damper regulators were available in our plant after extensive changes had been made. It was decided to utilize one of these for controlling the boiler damper in the usual manner and the oil flow to the burners by a lever-operated gate valve in the oil line. Necessary forgings were made by the plant blacksmith and the power-plant mechanic assembled the apparatus. Slots in bell-crank levers and a series of holes in the oil-valve operating lever allowed their travel to be changed to provide the proper ratio of fuel to air.

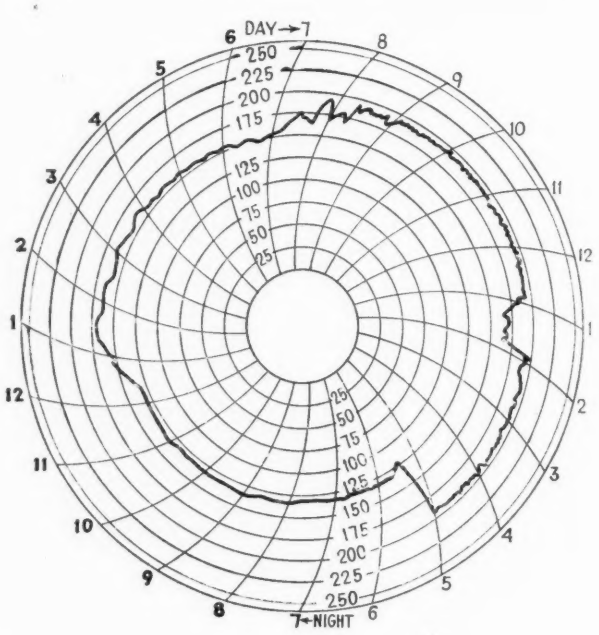
This device operated satisfactorily for some time, but wear at joints resulted in lost motion, and a lag between damper and oil valve opening gave too much variation in CO_2 for different damper positions. To overcome this, a portion of the damper-operating mechanism has been improved as in the figure, and a new oil valve substituted for the lever operated gate valve.

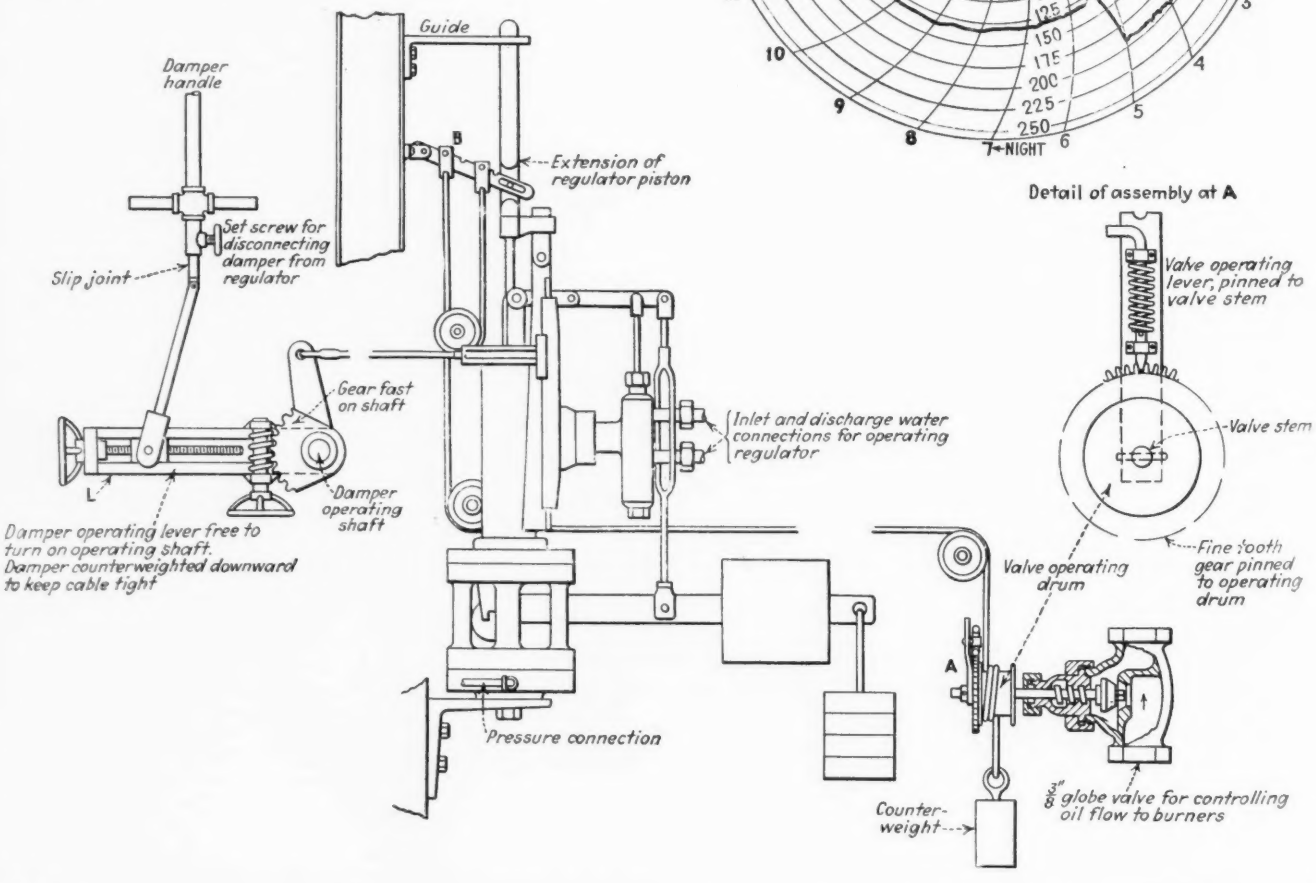
The worm and gear on the damper operating lever are discarded parts from mill machinery as are the handwheels. The slotted lever *L* was welded up from $\frac{5}{8}$ x $\frac{3}{4}$-in. bar stock. Lugs for supporting the worm shaft are welded to the lever. A rectangular steel block, drilled and tapped for a $\frac{3}{8}$-in. threaded screw, forms the sliding block used for adjusting the damper travel. A link pivoted at the sliding block connects to the damper handle. Adjustment of the worm allows the damper to travel in a different plane depending on the number of burners in use. Adjustment is also provided at *B* by notches in the pivoted bar.

The oil valve is made from a $\frac{3}{8}$-in. globe valve and gives ample oil for maximum requirement. The drum is loose on the valve stem, which was made longer by welding on an extension and turning it down to size. A fine-tooth spur gear serves as the notched wheel and is pinned to one end of a cable drum. A lever made from flat bar stock has a hub welded on at one end and drilled to slip over the valve stem and is pinned to it. This lever carries a pin flattened at one end to fit the spur-gear teeth and bent at right angles at the other end.

Adjustment of minimum oil pressure is secured by moving the regulator to the top position, disengaging the pin from the gear and closing the globe valve until desired minimum pressure is reached. Oil-valve travel can be adjusted by varying the travel at *B*. Lifting the valve operating lever pin from the gear and giving it one-quarter turn to a notch provided in the lever, cuts out the regulator and allows valve operation as a hand valve.

This device has been in operation several months with entire satisfaction. The pressure chart is representative of records consistently secured with the regulator which is attached to one of the two boilers in regular service. The other




Guide
Damper handle
B
Extension of regulator piston
Set screw for disconnecting damper from regulator
Slip joint
Gear fast on shaft
Damper operating shaft
L
Damper operating lever free to turn on operating shaft. Damper counterweighted downward to keep cable tight
Inlet and discharge water connections for operating regulator
Pressure connection
Detail of assembly at A
Valve operating lever, pinned to valve stem
Valve stem
Fine tooth gear pinned to operating drum
Valve operating drum
A
Counter-weight
⅜" globe valve for controlling oil flow to burners

boiler is fired by a combination of oil and waste fuel and is not under automatic regulation.

Most of the boiler load is dropped at 4.06 P.M. Night load is very light, usually requiring but one small burner tip, whereas the day load requires four large tips. Maximum CO_2 with our oil (which runs 11% hydrogen) is approximately 16% and we maintain an average of around 13%.

N. Plymouth, Mass. C. B. HUDSON

Remodeled Oil Switch Heated Excessively

AS A RESULT of neglected maintenance an oil switch for a 200-hp. 440-volt wound-rotor motor was in such bad condition that it had to be replaced. A suitable spare not being available, the plant electrician remodeled a 100-hp. starting compensator for use with the 200-hp. motor. Low voltage for starting not being required, the starting contacts were removed from the compensator. Three of these contacts were mounted on the running side, and connected in parallel with the running contacts, thus doubling their contact area. The overload relays were replaced by others rated at 400 amp. and the auto-transformer entirely disconnected.

When put into service, this switch ran warm. After several months of operation the machine operator stopped the motor because smoke was coming from the oil switch. The switch was found to be extremely hot. The immediate cause of the trouble proved to be defective connections at contact supports.

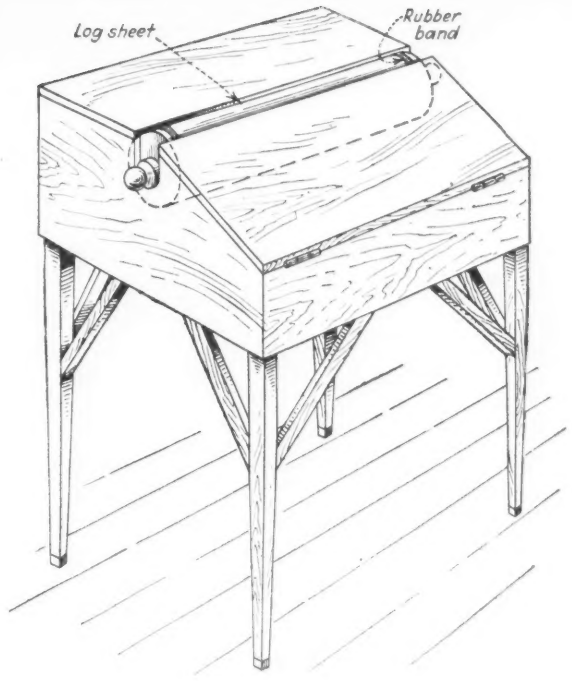
The switch had for some time been operating at a much higher temperature than supposed. Although the double contacts safely carried the motor current, the terminal studs and connectors between them and the contacts had not been increased in size. Overloading these under-sized connections caused warm operation of the switch. Sustained heating of the terminal studs had charred nearby insulation on the line conductors, which were also oil soaked. To correct the trouble the damaged line conductors were reinsulated with varnished-cambric tape, this insulation being unaffected by switch oil. The terminal studs were shunted by short insulated jumpers of flexible copper, and the original internal connectors were replaced with new ones having ample area. Larger contact springs were also installed so that contact would be maintained under greater pressure. After repairs were completed the oil switch operated with entire satisfaction, and maintenance costs proved to be very low.

In general, it is not advisable to attempt to increase the rating of current-interrupting equipment. If remodeling is undertaken, give careful attention to every detail to obtain satisfactory operation. Ultimate cost of remodeling is likely to prove high. Further, the performance of remodeled equipment is uncertain, while that of new equipment is guaranteed.

Oakland, Cal. RAY BARR GLEN.

Desk and Roll for Log Sheets

TO KEEP large daily plant-log sheets in good condition is always more or less of a problem. We have solved this problem in our plant with the desk and roll illustrated. The roll's circumference is equal to the length of the log sheet, which is wrapped around the roll and held in place by a rubber band at each end. The roll is then placed in the desk as



shown and the hour-to-hour records made on the proper lines, through the slot.

A knob on each end of the roll provides for easy turning of the roll without touching the log sheet. This sheet is covered, except for the narrow strip exposed on which to make the record, and does not have to be handled, consequently it is practically as clean when removed as when placed on the roll. The space within the desk is used for storing extra material for record purposes.

Cleveland, O. CHARLES A. ARMSTRONG.

Wild Guesses

AT THE N.A.P.E. Power Show in Pittsburgh, Semler Co., Jeannette, Pa., exhibited a 12-in. extra-heavy cast-iron flanged ell, urging visitors to guess its weight. Thousands of these guesses were recorded on little slips. According to last reports, they ranged all the way from 89 lb. to 2,000. These extremes we hope were not typical of the estimates, but rather scattering shots, possibly by members of the Ladies Auxiliary.

Plugged Line Wrecks Pump During Cleaning

A CENTRIFUGAL pump, used for handling liquid soap was wrecked while being cleaned with live steam at about 60 lb. gage. The casing was fractured and the rotor damaged. The steam supply was regulated by a 1-in. stop valve, but no pressure gage, reducing or relief valve were provided between the stop valve and the pump.

As long as there was an opening through the pump to the discharge the steam passed through and carried any deposit with it without an abnormal rise in pressure. One day when the pump was being cleaned the discharge happened to be plugged solid and the rise in steam pressure was sufficient to burst the casing. When a new pump was installed a reducing and a safety valve were installed on the steam line to limit to about 15 lb., the pressure that can be built up in the pump.

Kent, England. W. E. WARNER.

CURRENT COMMENT

Power Service Costs in a Hospital

READERS who saw the chart on page 431 of August *Power* may be interested to know about how power service costs run in a large hospital. The table shows this cost distribution for 1934 for Cincinnati General Hospital. Costs here given do not include depreciation, since the plant has already been "written off" on the books. Being a city institution, the plant pays no water bills and no taxes. These items, therefore, cannot be included. The costs listed consist of labor, coal and supplies.

The General Hospital is an 800-bed institution, but the number of patients cared for has reached nearly 1,000 several times in the last few years. The power plant furnishes light, heat, power, live steam, domestic hot water, compressed air, etc. for 27 buildings. Of these only 11 are ward buildings. The others include the Medical College, Administration Buildings, dormitories, pathological building, power plant, laundry, shop, garage, embalming college, etc.

All power is generated by three Hamilton Corliss engines,

1934	Salaries	Coal	Supplies	Total
Electric Power	$3,368.38	$4,400.33	$233.92	$8,002.63
Ice & Refrigeration	108.70	142.00	7.55	258.25
Heating Buildings	10,207.28	13,334.41	708.86	24,250.55
Heating Domestic Hot Water	3,578.29	4,674.53	248.50	8,501.32
Cooking, Sterlizing, etc	5,972.84	7,802.70	414.80	14,190.34
Laundry, Steam & Hot Water	1,931.95	2,523.83	134.17	4,589.95
Compressed Air	45.44	59.36	3.16	107.96
Total Cost	$25,212.88	$32,937.16	$1,750.96	$59,901.00

direct-connected to 250-kw. G.E. generators. Water, for building heating, is heated in the power plant by steam at 10 oz. pressure. Hot heating water is forced through all buildings by turbine-driven centrifugal pumps.

Cincinnati General Hospital has 26 electric and 7 hydraulic elevators. The power load is about 95% direct current and about 5% alternating current, the a.c. being used for X-ray, deep therapy and fluoroscopic purposes. The necessary alternating current is produced by a motor-generator set in the power plant.

A steam-driven ice machine is operated in the winter, and an electrically driven machine in the summer. Many boiler-room auxiliaries are likewise driven by steam in the winter and electricity in the summer.

Cincinnati, Ohio. ANTHONY A. FETTE
Chief Engineer,
Cincinnati General Hospital.

Lubricates Brush Holders With Graphite

I READ with interest Kermit B. Hoffman's discussion, "Eliminates Dust to Prevent Brushes Sticking in Holders." Powdered graphite makes a first-class lubricant and has the further advantage that it works into the pores of the brush-holder. This gives the metal a graphite polished finish and a minimum friction to brush movement. This smoothness is an aid to good operation. It does not, however do away with the necessity for systematic cleaning, but does make the brushes less dependant on cleaning and less likely to stick if this is not done. Lubrication in this way is to be recommended in all cases where motors are working in a hot or dirty atmosphere, under which conditions brush sticking is always a possibility.

Kent, England W. E. WARNER.

Compressed-Air Explosions Can Be Prevented

FAILURES of compressed-air containers from over-pressure have been discussed in the several recent articles in *Power*, but I wish to add a few comments. In some states it is compulsory and in practically all cases it is advisable to have such pressure vessels inspected in the shop when they are being built, by an authorized state or insurance inspector. Periodic inspections by an authorized inspector, familiar with various conditions do much to prevent accidents.

Deterioration by corrosion is a serious problem with the average air vessel. It is advisable to protect the lower internal surfaces of such tanks, where these surfaces are accessible, with a coating of anti-corrosive paint. Condensate on unprotected steel will usually cause rapid corrosion and pitting, which should be removed by periodic blowing down.

Other defects are those caused by vibration transmitted to the air receiver by piping from the compressor. Too small a discharge line, having sharp bends, from the compressor will cause vibrations to be set up by air pulsations. Similarly vibrations may be caused by a compressor being loose on its foundation. Fatigue cracks may develop in the receiver-tank shell plate as a result of these vibrations. In extreme cases serious chafing of metal has occurred on horizontal-tank bottoms, set on concrete piers.

Common failures are those directly or indirectly caused by high air temperatures, which may result from failure of jacket water. Scaled and obstructed water jackets also cause high discharge temperatures. Leaky discharge valves in a compressor allow part of the heated air to pass back into the intake to pass through the compressor again and become hotter at each stroke. This condition also causes high discharge temperatures.

After operating a compressed-air system for some time oil vapor will pass through the piping into the receiver. High air temperatures cause more or less carbonization of oil in the cylinders and ports of the compressor. Particles of this carbon detach from these points and adhere to the oil film on receiver and piping surfaces.

With a compressor-air system in this condition an explosion is easily possible. A sudden rise in air temperature to the receiver may cause a practically instantaneous and violent spontaneous combustion of the carbon and oil mixture. Such explosions are not infrequent, but may be prevented easily by using high grade oil in the compressor and only sufficient for proper lubrication.

Ample cool water through cylinder jackets and maintaining compressor valves in proper condition will do much toward preventing an excessive air temperature. Maintenance outside of the compressor consists of keeping internal surfaces of discharge piping and receiver clean.

Cleveland, O. M. E. WAGNER

FEDERAL LICENSING

Editor's Note—In September *Power*, page 496, appeared Chester G. Robinson's proposal that the Federal government license power operating engineers. A number of comments have been received. Here are excerpts from four of them.

Use Present Boards

THE suggestion is excellent. The function of the operating engineer is an important one and carries with it a considerable degree of responsibility, for his is the guiding brain of the power plant's mechanism and personnel. It is up to him to so direct the operation of the plant that an economical result will be produced. Not only, however, does performance of the equipment depend upon his ability and good judgment, but also in emergency the very lives of his men depend upon him. For these reasons alone, employers should be able to choose their operating engineers by some fixed nation-wide standard, rather than having to depend upon the variable standards that exist under the present set-up.

Quite frequently, in addition to the above responsibilities, the operating engineer is taken unfair advantage of in being requested to make a layout of some prospective extension of the mechanical equipment. Particularly is this the case when he is employed by an organization that does not retain the services of a consulting engineer. And, too, he even more frequently is called upon to advise in choice and purchase of new equipment and replacement parts. All of these require a knowledge and analytical ability that not all men who term themselves operating engineers today possess.

Undoubtedly, as Mr. Robinson said, the present form of licensing operating engineers has had a tendency to place what should be a profession on the same footing as a trade. Independent engineers, realizing the benefits to be derived from proper licensing, have been at work for some years to place their business on a professional basis. As indicated in the Editor's footnote, they have succeeded in doing so in many states, and they bid fair to carry other states soon.

The unfortunate part of this method of licensing lies in the fact that interstate practice presents a special problem. At present, I understand that there is a system of reciprocity between states that permits an engineer from one state to practice in another provided he does not move his offices into the second state. Of course all this would be eliminated if there were a federal system of licensing, which has yet to be proven "constitutional" (a sadly overworked word).

But until such time when the feature of federal licensing can be more fully gone into and worked out, why cannot the operating engineers be included in the present state set-up and be taken care of by the examining boards that now exist?

Richmond, Va. RICHARD P. HANKINS.

Examinations Too Easy

I DON'T know much about licensing laws in other cities and states, but when I was a schoolboy in Nebraska, a fireman was sick, so I took charge of a plant supplying steam to a 4-story office building, a theater with 5,000 sq.ft. of space, and a hotel! I was not told of some open 5-in. returns from the theater, and the supply lines to the theater (about 400 ft. away) were shut off. I lost all water from the boiler, so I shut down and allowed water to reenter the boiler with the fire drawn. Nothing happened (at least I'm still alive) and the plant ran for years!

Usually examinations are too easy. In Detroit, for example, the steps in licensing are almost ridiculous: 3rd class 50 hp., 2nd class 100, 1st class unlimited. In other words, the same examination is required for a small laundry or bath house using 150 hp. at 50 lb. and the 300,000-kw. Trenton Channel or 250,000-kw., 1,400-lb. Ford plants (actually, no license is required in these plants because they are not in the City of Detroit). The results of laws so antiquated is typified by a recent incident in a flour mill, which pays its 1st-class engineer less than most firemen get. He asked naïvely why a condenser anyhow—it seemed a difficult way to save water!

Detroit, Mich. F. G. D., SR.

Already Done on Steamboats

A GOOD many things can be said in favor of licensing by the federal government. In my opinion, all power plants, irrespective of the source of motive power, should come under federal supervision, with one common licensing law throughout the United States.

Instead of the haphazard methods now employed in some states toward licensing, detrimental not only to engineers and plant operators but to the general public, federal supervision would standardize the methods employed, elevate standards, and result in more safe and efficient operation. There are some who say that such a law would be unconstitutional, but it is in fact already being done in marine power plants, and with good results.

Federal engineer officers of the Steamboat Inspection Service who have charge of licensing marine engineers are capable and are certain that a man issued a certain grade license is capable of operating a plant of that grade. No marine engineer license is issued to a man who has as his only qualifications a letter from someone with political influence. If the system works for marine power plants, I see no reason why it wouldn't work in others.

Baltimore, Md. JOHN H. SCHNEIDER.

Not Practical

MR. Robinson's idea is impractical and unnecessary. The modern trend of the Federal Government to usurp the rights of the various States must not be encouraged. The grade of examiner I have met in my small travels is distinctly high, and in his appointment political consideration was not used. In fact, the Engineer Examiners are, I submit, one group of State Officials who are singularly free from political influence. In their daily work they come into contact with the various mechanical and boiler inspectors of the big insurance companies, and their ignorance, if any, would be reported upon by them. The companies aforesaid would soon get after a matter of this kind, because their own money would be involved in the payment of claims, etc.

Several States have remarkably good licensing laws and splendid question papers. The standard of passing is high and a man can be proud of the license he gains. In other States, less advanced, the examiners usually recognize these licenses and issue discretionary licenses for their own State.

To advance as an argument that a Federal license would enable the holder to travel further afield is not good reasoning. Does Mr. Robinson suggest that a Federal license would get much consideration from a real Californian employer if the applicant were not a native son?

Passaic, N. J. MARK BELL

READERS' PROBLEMS

QUESTIONS for Our Readers

Polishing the Plant

Question 1

MY PLANT *has the conventional brass railings around the engines and compressors, tile walls and cement floor. I've had considerable trouble keeping the railings shined, because people touch them. If I use a light film of oil, they collect dust and are disagreeable to touch. I also have a lot of brass-trimmed apparatus. Is there any substitute for the usual hard polishing? Couldn't I use painted or enameled railings that could simply be washed down? I have the floors painted and thus avoid trouble with oil spots, but any spattered oil makes it very slick. What paint should I use? Further, oil is occasionally thrown from flywheels against the tiling and soaks into the mortar between tile-faced bricks. How can I remove and thereafter prevent this discoloration?*—A.W.W.

Rock Salt in the Firebox?

Question 2

WHAT *are the advantages and disadvantages of using rock salt in the firebox for disintegrating soot? Are there any special products for the same purpose?*—H.K.T.

Suitable answers to these questions from readers will be paid for if space is available for their publication.

Exciter Cannot Maintain Normal Voltage

WE ARE *having trouble with the voltage regulation on an exciter in our plant. This exciter is controlled by a voltage regulator. A supposed expert has checked the regulator and pronounced it O.K. The exciter responds very slowly, however, even when the rheostat is shunted by the regulator contacts. The exciter is rated at 200 kw. and is driven by a steam turbine and an induction motor. With no load on the exciter it will build up to 130 volts, but when loaded to 800 amp. the voltage drops to 120, with the field rheostat cut out of circuit. The series- and the shunt-field winding on this machine are not opposed, because we have paralleled it with two other exciters.*—H.M.F.

Apparently the trouble is being caused by the series- and shunt-field windings being connected in opposition. The fact that you can operate this machine in parallel with other exciters does not indicate that the fields are not in opposition. If the field coils of this exciter are in opposition and it is connected in parallel with other machines, the only difficulty experienced would be to make it take its proper share of the load. If it lost the load entirely it would simply float on the circuit as a motor, under which conditions the two field windings would have the correct polarity.

If the field coils have the correct polarity and the regulator is operating properly, then the difficulty must be in the wiring between the field short-circuiting contacts and the exciter. If there were an opening in this wiring of course the regulator could not have any effect on the exciter's voltage. One thing that you might try on the exciter is to disconnect the series winding entirely, and try operating the exciter as a shunt machine. If the field coils have been in opposition, you will be able to get a higher voltage as a shunt machine than when operating with the series field winding in the circuit.

DIESEL EXHAUST HEAT RISES STEADILY

ANSWERS to September Question 1

The Question

Our ice plant was converted to diesel power this spring and ran 24 hr. a day through the summer. Recently load has dropped off, so that we are running only one shift now. My pyrometer now shows steadily rising exhaust temperatures through the day, while before they held steady. Load is nearly constant, according to my watt-hour meter. What is wrong?—F.F.S.

Watch Cooling-Water Temperature

I AM going to assume that the same quality of oil is being used as when operating full time and the engine is a single-cylinder, 2-cycle unit. When the engine has been operating 2 hours after 8 or 10 hours shut down there should be no change in the exhaust temperature if the load is held constant (this can only be accomplished by maintaining uniform suction and discharge pressures in the refrigeration system), and no change in the quantity and temperature of the water supply to the cylinder jacket.

I attribute the gradual rise in the exhaust temperature due to an increasing load on the engine, caused from a higher condenser or lower suction pressure. This slowly rising exhaust temperature can also be caused by a gradual warming up of the water going to the engine jacket.

I wish to suggest that if F.F.S. is using a cooling tower in connection with his engine water supply, to watch closely the temperature of the water to the cylinder and see if there is any increase in the temperature during the day's operation. Where a cooling tower is in service, the temperature of the water is more uniform when operating 24 hours a day than when shut down part of the time. The reason is obvious.

The gradual rise in the exhaust temperature of an oil engine cannot be caused by a fluctuation in the air or fuel oil supplied to the cylinder, as a fluctuation of either would cause a rising and lowering of the temperature instead of a gradual rise.

Thermometers installed in the water lines to and from the cylinder water jackets of oil engines are very valuable in service to the operator in charge. By their use a slight change in the temperature of the water going to the cylinder jackets can be detected and possibly remedied. And any change in the temperature of the water leaving the jacket can be discovered and the cause determined. For instance, if the water leaving the jacket is gradually warming up throughout the day, there are three possible causes for such a condition, namely: The supply can be diminishing, gradually warming up, or engine load increasing.

If the water leaving the engine cylinder jacket gradually lowers in temperature while the supply is kept constant, the cause is generally due to a slow accumulation of scale on the cylinder walls or a mass of mud precipitated in parts of the water spaces. This condition also causes higher exhaust temperature.

I am sorry that F.F.S. did not state what the maximum temperature of the exhaust was just before the shutdown for the day and how much higher it was than when operating normally 24 hours per day.

Memphis, Tenn. J. W. DICKSON

Slow Heating of Parts

THE probable cause of the rising exhaust temperature is slow heating of the engine to operating temperatures. When the unit was operating 24 hours a day, it reached this temperature and held it, therefore the exhaust did not vary much with a constant load. An engine starting from cold will take several hours for all parts to reach a

steady temperature if it is of the slow-speed, heavy-duty type due to the bulk of material in the unit. This will explain the ordinary temperature rise of the exhaust. Warming up of the inlet air and the cooling water will also have some effect on exhaust temperature. This may not be the cause of F.F.S.'s trouble, but due to the lack of data in the question I will not take up more space trying to list all the causes.

Walthill, Neb. WM. W. DINGWALL

Probably Overloaded Engine Condition

THE most probable cause is that, running only 8 hours in place of 24 hours a day, there may be an overload on the engine. This in spite of the fact that the watt-hour meter reads constant. A second possibility is that the exhaust valves and seats are cut, allowing the leakage of very hot gases to exhaust. This condition may have occurred during a previous overload spell and was caused thus:

A diesel should not be overloaded because the fuel charge increases with the load. If the fuel increase is more than can be burned with the air available this charge may still be burning when the exhaust valve opens. When this occurs the temperature of the exhaust gases is very high and, in time, this will cut both valve and seat due to heat and high velocity.

Passaic, N. J. MARK BELL

BACTERIA IMMUNE TO CHLORINE?

ANSWERS to September Question 2

The Question

WE HAVE *two condensing turbines developing 5,500 kw., and we take our circulating water from a river. The temperature of this river water ranges from 72 to 82 deg. during the summer, and up until three years ago, we had trouble from slime in the condenser tubes during the summer months. We had to clean the condenser tubes every two days, which greatly curtailed our output just when most needed.*

Three years ago I started to use chlorine, introducing it at the rate of 3½ lb. per million gal., at a point in the intake tunnel approx. 600 ft. from the condensers, and slime conditions were so improved that we could carry the turbines on the line two weeks before it became necessary to clean condensers, the amount of chlorine fed being gradually reduced to 2½ lb. per million gals. of water. Chlorine was used from July 1 until Sept. 20, 1933, and again started July 5, 1934. By Aug. 15, 1934, it was noticed that the chlorine treatment was not as effective as it was the first year, weekly condenser cleaning being necessary, and this is again true this year, although we have again increased the rate of chlorine fed to 4½ lb. per million gal. of water.

Our chemist tells me that the slime bacteria is probably becoming immune to the chlorine, and that I ought to alternate the chlorine treatment with ammonia to break down the bacteria resistance to chlorine, but I would like to hear some other opinions before I do this. Careful inspection of the condensers, after using chlorine two summers, showed no signs of corrosion.—A.H.W.

Two Other Methods of Introducing Chlorine

DE-SLIMING condenser tubes by the use of chlorine is primarily a sterilizing action by which the algae growth forming the basis of the slime are killed. Before successful sterilization can be accomplished, sufficient chlorine must first be added to the water to (1) react with the mineral compounds present in the water, (2) react with the organic compounds, and (3) sterilize the bacteria in the water. Any chlorine left after these prior demands are satisfied is available for attacking the slime growth. In practice this amounts to injecting sufficient chlorine to satisfy the demand of the water plus an excess, or residual, of 0.2 to 1.0 part per million (p.p.m.). This residual should be available at the condenser inlet, the amount depending, of course, upon the type and extent of algae growth. The total dosage is usually between 0.8 p.p.m. and 2.0 p.p.m., but may be higher. The chlorine residual should be determined by the ortho-tolidine test which has been developed for the purpose.

As the chlorine reactions are not instantaneous, it will be found that the longer chlorine is held in solution before reaching the condenser, the more chlorine is required to satisfy the demand of the water. Consequently, larger doses are required to produce a desired residual when the chlorine is injected some distance from the condenser rather than near to it.

The data submitted with the question indicate that the total dosage used was only 0.3 to 0.54 p.p.m. and that the chlorine was injected into the circulating water some 600 ft. from the condenser. In view of the foregoing discussion it would seem advisable for your correspondent to increase the dosage until a residual of about 0.5 p.p.m. is obtained at the condenser inlet, and also to inject the gas somewhat nearer to the condenser.

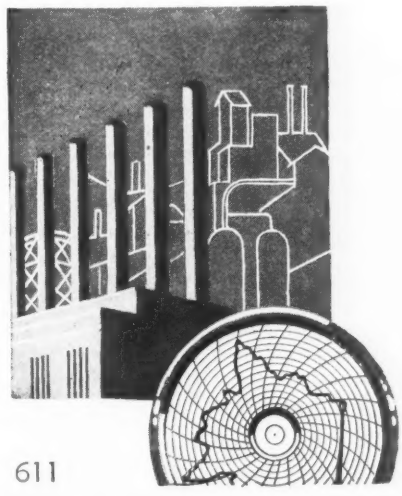
Unfortunately the question does not include data as to the total amount of chlorine used, nor as to the length and frequency of dosage, presuming that the intermittent system is followed. Time of contact between chlorine and slime as determined by the length of dosage is an important factor. Experience has shown that some forms of slime growth can be controlled with a 4-minute dose, while other forms, existing in the same water, require 10 to 15 min. dose at the same residual. Therefore, any change in form of slime growth which might occur from year to year might also require a considerable change in duration of chlorine dosage.

Reference is made to the ammonia-chlorine, or chloramine, method. While this method has been used with some success, the treatment is complicated by the addition of the second gas. It may be found worth while to try several simpler methods based on chlorine which have been worked out recently with considerable success. Both are based on the principle of applying the chlorine directly to the slime on the condenser tubes. As the concentrations used are low, there has been no serious corrosion of the condenser tubes or tube sheets.

The first method consists of injecting chlorine gas directly into the water-box of the condenser in the proportion of 2 lb. per 100 cu.ft. of water space. The work is usually done just after the unit comes out of service, so that the slime surfaces are thoroughly wet. The gas is injected before the condenser is completely emptied. By allowing the remainder of the water to drain out, sufficient draft is created to distribute the gas throughout all tubes and thus bring the chlorine into intimate contact with the slime. The chlorine is allowed to soak in the condenser for 15-30 min. and is then flushed out by operating the circulating pump. Exposure to the gas kills the slime, so that the flushing water removes the growth and mud from the tubes. A condenser cleaned in this manner at the same intervals used formerly in rubber plugging showed an increase in vacuum of 0.3 in. Hg.

The second method consists of filling the condenser water-boxes and tubes with a water solution of chloride of lime and allowing the condenser to soak overnight (about 10 hr.). Solution and dirt are then flushed out when the unit is started in the morning. The amount of chloride of lime used is calculated on the basis of making a solution containing about 25-30 p.p.m. of available chlorine. Commercial chloride of lime (bleaching powder) contains about 35% available chlorine. Cost usually does not run more than 25¢ per treatment. This method was found to be very effective in removing slime. It provided a cheap and convenient means for cleaning condensers and almost completely eliminated the use of rubber plugs. Because the condenser could thus be cleaned more frequently than previously, there was a net gain in vacuum of 0.2 in. Hg.

Both of the foregoing methods are simply substitutes for cleaning condensers with rub-



ber plugs. Better results are obtained when the condenser is maintained in a uniformly clean condition. The latter may be realized through the use of the intermittent de-sliming process.

New York, N. Y. WILLIAM WELCH, JR.
Interborough Rapid Transit Co.

Maintain Residual Chlorine at Condenser Inlet

IT SEEMS that A.H.W. has not given *Power* readers quite all the necessary data to suggest an answer to his question. His figures of 3½, 2½ and 4½ lb. of chlorine per million gallons of water do not mean anything to other readers, since we do not know whether or not he is carrying any residual chlorine in the condenser water. To keep the condensers clean there must be an excess of chlorine over the actual chlorine demand of the water. Four and one-half pounds per million gallons is slightly more than 0.5 part per million and quite possibly the demand of A.H.W.'s water may be that much or more—we do not know.

We use water from a small lake and a ten minute dose of chlorine every three hours providing a residual of 0.2 p.p.m. at the circulating pumps has kept our condenser tubes perfectly clean for two years.

Since the water in the question is a river water and only used once, it seems hardly possible that any bacteria could have a chance to build up an immunity to chlorine, even if such a thing were possible.

Personally, I wish A.H.W. had given us the type of dosage he uses (continuous or intermittent) and the residual he carries, then possibly a definite correction could be suggested for his trouble.

W. L. STARKWEATHER.
Cedar Rapids, Iowa
Iowa Electric Light & Power Co.

Treatment with Ammonia and Chlorine Uncertain

ONE of the most necessary requirements in chlorinating water is the maintenance of a minimum residual chlorine content of 0.1 to 0.2 p.p.m.

A feed of 2½ to 4½ lb. of chlorine per million gallons of water (0.30-0.54 p.p.m.) is by no means satisfactory in destroying the slime in condensers formed by algae, diatoms and other micro-organisms.

The dosage required in chlorinating will vary considerably depending upon the nature of the effluent, the temperature and stage of the river water. The dosage is also affected by the presence of oxidizable salts or by the hydrogen-ion concentration, since oxidation results more quickly in presence of free carbonic acid.

In determination of residual chlorine with ortho-toludine solution, ferric iron has been regarded as not interfering unless in relatively large amounts, however, the presence of manganese and nitrites will cause large errors.

Recently determiniations of traces of chlorine made with benzidine hydrochloride solution have been recommended. Standards made up of mixture of 15 per cent copper sulphate and 0.5 per cent picric acid, give a bright green color, easy enough to distinguish quantities of chlorine below 0.1 p.p.m.

The practical method is to regulate the chlorine dosing device so that frequent samples, taken at a point in the distribution system that allow five minutes contact period, show a residual chlorine value of 0.1 to 0.2 p.p.m.

Treatment with ammonia and chlorine appears to be an uncertain proposition. Although some had excellent results, other experiences were not encouraging.

Copper sulphate and potassium permanganate have been used as an algicide, but in most cases did not prove satisfactory.

St. Louis, Mo. MARCUS COOK

Some Organisms Not Affected by Chlorine

I BELIEVE that the assumption that after a period of time water organisms become immune to chlorination is a fallacy; it is my opinion that new organisms are appearing in the water that are impervious to the chlorine treatment.

Chlorination is usually effective with the ordinary vegetable algaes (Thallophyta) and particularly the common pond scum (Spirogyra). The reproductive or spore cells of this class of vegetable life are very hardy, enduring not only wide extremes of temperature but arid conditions to such degree that they may dry up and fly about in the air, yet, if they fall in a body of water with correct temperature conditions, will thrive and grow.

There are multi-celled forms of water organisms (of a higher order, of course, than the algaes, amoeba and paramecia) belonging to the protozoan family on which chlorine, in ordinary doses, is not effective nor are other commonly used algaecides. I know of many instances where these as well as even higher forms of organisms have occurred in such abundance as to clog filters in a very short time and almost result in shutting down of water systems. More particularly active in this connection are organisms belonging to the Euglena and Rotifera families.

The customary procedure when difficulty develops with an unusual organism, particularly insects, algae and protozoan forms, is to collect samples in beakers and experiment in laboratories with various concentrations of chlorine, copper sulphate, Paris green or other algaecides and larvacides, including potassium permanganate. Naturally, the effects of these chemicals on the equipment must be considered.

Oftentimes, in city water supplies especially, chlorine is found in the natural supply in which algae is also growing in certain forms. (Chlorine so found is indicative, of course, of decaying animal or vegetable matter which has found its way into the water supply.) Great care must be exercised in the conditioning of such water as the algae must be destroyed, the chlorine removed and the water otherwise filtered and purified and yet it must not contain anything unfit for human consumption.

Kingsport, Tenn. BENJAMIN E. LINGAR

MANUFACTURERS' BULLETINS

(Further Bulletins will be found on page 624)

Combustion Control—Smoot Engrg. Corp., 2240 Diversey Parkway, Chicago, Ill. 32-page, illustrated Data Book No. S-20 contains a complete discussion of basic problems of boiler operation and their importance in efficient steam generation. Full-page diagrams show application of mechanical control.

Dynamometer — Falk Corp., Milwaukee, Wis. 8-page bulletin No. 920 shows construction and operation of "Wellometer" dynamometer primarily for oil-field use.

Worthington—Worthington Pump & Machinery Corp., Harrison, N. J. Bulletin No. L-620-B6B, Air Compressor Units; No. L-620-B5A, Air Compressor Units for Oil and Gas Engine Starting; No. W-200-B2A, Surface Condensers; No. L-611-B3A, Steam Booster Compressors. No. W-450-B19, Deep Well Turbine Pumps, Types Q and QA.

Refrigerating Units — Carbondale Machine Corp., Harrison, N. J. 4-page bulletin No. 1105 illustrates Freon or methyl chloride combined refrigerating units for air conditioning and general refrigeration service.

Air-Conditioning Units — Carbondale Machine Corp., Harrison, N. J. Single sheets Nos. 114-1, 2 and 3 describe and illustrate ceiling and horizontal air-conditioning units.

Belts—Manhattan Rubber Mfg. Division of Raybestos-Manhattan, Inc., Passaic, N. J. 4-page illustrated bulletin No. 6825A gives descriptions and specifications and technical data on "Condor Whipcord" endless belt.

Time Controls — Automatic Temperature Control Co., Philadelphia, Pa. 16-page catalog T-C, treating time controlling for industrial operations and processes.

Blow-Off Valves — Yarnall-Waring Co., Chestnut Hill, Philadelphia, Pa. Bulletin No. B-419 illustrates and describes forged steel blow-off valves for 600 to 1,500 lb. working pressures.

Lubricators—Nathan Mfg. Co., 250 Park Ave., New York, N. Y. Bulletins Nos. 101-5 illustrate and show applications for ratchet or rotary drive mechanical lubricators. Bulletin No. 202 illustrates lubricators for stationary engines, pumps, compressors, etc. Bulletin No. 201 describes oil cups and grease cups.

Welding—Lincoln Electric Co., Cleveland, Ohio. 16-page bulletin illustrates and describes process of hard facing and overlaying by welding.

Gate Valves—Lunkenheimer Co., Cincinnati, Ohio. Circular No. 504 illustrates and gives complete information on "King-clip" gate valves.

Belting—Boston Woven Hose & Rubber Co., Box 1071, Boston, Mass. 12-page booklet on "Continuous Vulcanization of Transmission Belting."

Steel — Republic Steel Corp., Massillon, Ohio. 8-page folder discusses alloy sheet steel (copper—nickel—molybdenum).

Wire Nails—Republic Steel Corp., Massillon, Ohio. Form ADV. 226-B gives 40 pages of information on wire, wire nails and fence posts. Is profusely illustrated.

Bearing Lubrication—Imperial Electric Co., Akron, Ohio. Sheet on lubrication of bearings and electrical machinery.

Motor—U. S. Electrical Motors, Inc., 200 East Slauson Ave., Los Angeles, Calif. Bulletins Nos. F777 and F836 give descriptions and illustrate uses for "Varidrive" motor.

Blowers—Roots-Connersville Blower Corp., Connersville, Ind. Bulletin 21-B-17. 4 pages. Illustrates and gives complete description of "Victor-Acme" rotary positive blowers for pressure or vacuum service.

Steam Accumulators—Foster-Wheeler Corp., 165 Broadway, New York, N. Y. 8-page Bulletin No. RA-35-5 illustrates principles of operation and use of "Ruths" accumulators.

Welders—Lincoln Electric Co., Cleveland, Ohio. Two 4-page Bulletins Nos. 309-10 give general specifications, construction and assembly of engine-driven "Shield Arc" welders.

Phenol Fibre—Continental-Diamond Fibre Co., Bridgeport, Montgomery County, Pa. 46-page catalog covers properties, manufacture and uses of "Dilecto" laminated phenolic material.

THE ENGINEER'S BOOKSHELF

Air Conditioning

LEWIS' NEW AIR CONDITIONING FOR COMFORT (2nd edition)—*By Samuel R. Lewis, consulting engineer. Published by Keeney Publishing Co. 6 North Michigan Ave., Chicago, Ill. 277 pages, 8 x 5½ in. Cloth. Illustrated. Price $2.50.*

From experience resulting from use in engineering practice, this text on air conditioning has been completely rewritten and enlarged. Two chapters not included in the first edition explain in detail the design of a year-round air-conditioning system for an office building, which includes banking space, offices, stores, restaurant, and kitchen. Similarly, two rewritten chapters cover the design for heating and cooling a residence. New and improved record sheets are given for both the office building and residence.

One chapter devoted to operating costs contains only six pages of information covering both heating and air conditioning costs. The value of the book would have been greatly enhanced had more data of this kind been included. There are in all 17 chapters.

Cast Metals

CAST METALS HANDBOOK (1935)—*Published by American Foundrymen's Ass'n. 222 West Adams St., Chicago, Ill. 512 pages (423 text, rest ads), 6x9 in. Semi-flexible cloth. Price $4 (free to members).*

First handbook devoted exclusively to properties and applications of cast materials, this text brings up-to-date information on castings and rectifies erroneous and obsolete data on which many engineers still base calculations. For the power equipment designer who uses cast materials, this is the book.

Eight sections include: recommendations to casting designers, recommendations to casting users, one section each on properties and applications of cast iron, malleable iron, steel and non-ferrous cast metals, a cross-index, and an advertising section of 99 pages. First section includes data on patterns, second lists things buyers should tell suppliers to obtain correct estimates. Other technical sections include such data as heat, corrosion and wear resistance, properties at various temperatures, etc., in addition to usual physical properties.

Electronics

INDUSTRIAL ELECTRONICS (1935)—*By F. H. Gulliksen and E. H. Vedder. Published by John Wiley & Sons, Inc., 440 4th Ave., New York, N. Y., and Chapman & Hall, Ltd., London, England. 245 pages, 6 x 9 in. Cloth. 245 illustrations. Price $3.50.*

Electronics devices are now used in almost countless forms. In this book an attempt has been made to present in a practical way important types and their industrial applications. The work is divided into four parts. Part I deals briefly with the characteristics of the various types of electronic tubes—light-sensitive tubes and cells, high-vacuum tubes and gas-filled tubes. Part II shows typical ways of controlling grid and igniter-actuated tubes, such as circuits for high-vacuum amplifiers, for grid-controlled gaseous tubes and ignition circuits.

Part III is devoted to commercial electronic instruments and control equipments and their applications. These include light-sensitive control devices, indicating and recording devices, rectification and frequency conversion, welder control, oil-burner control, and applications to automatic synchronizers, time relays, cycle spliters and protective relays. Part IV covers electronic regulators for voltage, speed, register, processes and temperature.

The practical treatment of the subjects and the wide range of applications included make this book useful to practically everyone interested in industrial electronic tube uses.

High-Speed Diesels

THE MODERN DIESEL (3rd Edition)—*Published by Iliffe & Sons, Ltd., Dorset House, Stamford St., London, S.E.1., England. 228 pages, 5 x 7 in. Cloth. Illustrated. Price 3/6 net.*

Standard small British text on high-speed diesels, this volume deals principally with engines for road, rail, aircraft and marine work. This edition adds data and illustrations on new engines, and injection systems, plus reference to developments in railcar engines. A comprehensive index has also been added to this edition. A fine statement of the present position of the diesel in the transportation field and comparison of it and the gasoline engine is included.

Brief Reviews

DIESEL ENGINE POTENTIALITIES AND POSSIBILITIES IN RAIL TRANSPORTATION (1935). *By A. I. Lipetz, consulting engineer. Published as Research Bulletin No. 49, Engineering Experiment Station, Purdue University, Lafayette, Ind. 48 pages, three illustrations, paper. Price 25 cents.*

BOILERS, ECONOMIZERS, AIR HEATERS AND PIPING (1935). *Report of the Boilers Subcommittee of the Prime Movers Committee, Edison Electric Institute. Publication No. C4, by the Institute, 420 Lexington Ave., New York, N. Y. Price 60 cents to members and employees, $1.50 to non-members.*—Contains statements by operating companies and manufacturers on leakage and tube starvation in boiler tube furnaces and superheaters, corrective measures, water wall and economizer operation, steam washers, boiler drums, behavior of metals at high temperatures, pipe welding, boiler construction, foreign boiler developments and descriptions of recent designs and installations of boilers and auxiliary equipment.

LIST OF FUNDAMENTAL RESEARCH PROBLEMS IN WELDING (1935). *Compiled by Fundamental Research Committee, American Bureau of Welding. Published as a separate section, August journal, by American Welding Society, 33 W. 39th St., New York, N. Y. 20 pages.*—Research problems, research in progress and developments in welding technique during second half of 1934.

CANADIAN COAL MINES (1935). *Published by Dominion Fuel Board, Victoria Memorial Museum, Ottawa, Canada.*—Ten colored charts graphically illustrate operating costs and revenues of Canadian coal-mining districts during 1931-34. Constructed on comparative basis to show cost details and changes in details since inception of survey in 1931.

NATIONAL PUBLIC WORKS (1935). *Published by The Communications and Transit Organization, League of Nations, Geneva, Switzerland. Available in the United States from World Peace Foundation, 8 West 40th St., New York, N. Y. 226 pages, Paper, Price $2.*—Second volume giving most recent results of inquiry on National Public Works throughout the world.

MANUAL OF AMERICAN STANDARDS (1935). *Published by the American Standards Association, 29 W. 39th St., New York, N. Y. Free.*—Indexed list of engineering and industrial standards and safety codes approved by American Standards Association.

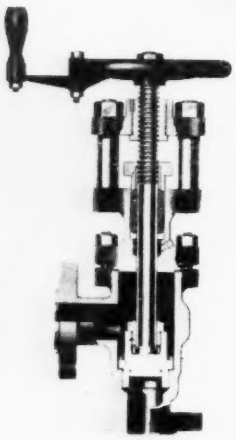
CITY OF SEATTLE. DEPARTMENT OF LIGHTING ANNUAL REPORT (1935). *136 pages, 6x9, paper. Profusely illustrated.*—Annual report for 1934.

PROCEDURE HANDBOOK OF ARC WELDING DESIGN AND PRACTICE (1935). *Published by Lincoln Electric Co., Cleveland, Ohio. 586 pages, more than 700 illustrations.*—Divided into eight principal sections which deal with important phases of arc welding. Added features include American Welding Society specifications for filler metal, method of determining amount of current carried by electrode, procedures, speeds and costs for making all types of welds in sheet metal, A.S.M.E. Boiler Code requirements for butt-welds in heavy plate, hard-facing of ferrous metals, examples of redsigning for arc welding, use of arc welding in making and repairing cutting tools and dies, speed of welding oil and gas pipelines, etc.

HYDRAULIC POWER COMMITTEE, E. E. I. *420 Lexington Ave., New York, N. Y.*—Minutes of first meeting held in Pittsburgh, Pa., April 14, 15. Abstracts and outlines of reports, letters and short articles on hydropower projects.

ZEOLITES; MINING, PROCESSING, MANUFACTURE AND USES (1935). *Published by The Permutit Co., 330 West 42nd St., New York, N. Y. 32 pages, 84 illustrations, paper. Free.*—First accurate up-to-date detailed paper on subject.

WHAT'S NEW IN PLANT EQUIPMENT



BLOW-OFF VALVE

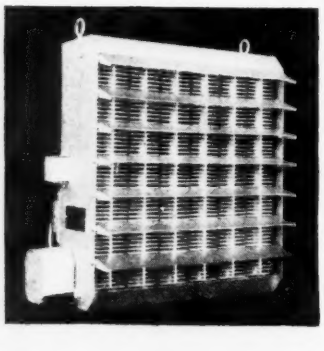
FORGED steel, hard-seat blow-off valve made for two pressure ranges, 600 and 1,500 lb., is of seat and disk type, with inlet under seat. Body is flanged steel forging of angle pattern with side outlet. Bottom flanged inlet nozzle is screwed in and welded. Stainless steel seat ring screwed into nozzle of lower end of body. Stainless steel disk is attached to stem by disk nut pinned in place. Lip on lower end of disk checks wire-drawing action of blow-down and protects bearing faces of seat and disk. When valve is opened top of disk nut seats against bottom of bonnet permitting repacking under pressure. Condensing chamber in bonnet is provided with small test outlet to relieve pressure before repacking. Alemite fitting on cross yoke provides lubrication of stem and operating handle on hand-wheel gives added power for closing valve against high pressures. Bulletin No. B-419.

Yarnall-Waring Co., Chestnut Hill, Philadelphia, Pa.

ELECTRIC HEATER

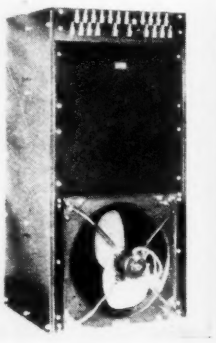
VARIETY of heat-producing sizes of "Electromode" heaters have electric heating units consisting of helicoil sheath-wire type resistance heater element cast integral with aluminum fin type grid. Heat conducted through fin area and carried off by forced air circulation. Maximum temperature of 250 deg. Rectangular and round shapes. Available in portable, built-in-wall, and industrial type units.

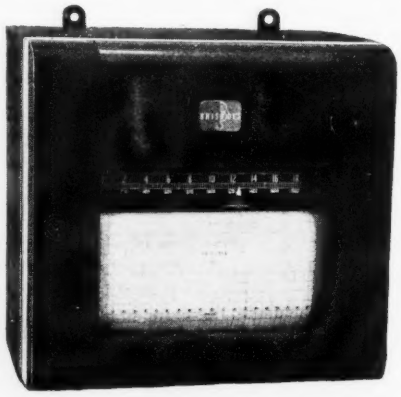
Electric Air Heater Co., Division of American Foundry Equipment Co., Mishawaka, Ind.



SPEED REGULATING RESISTORS

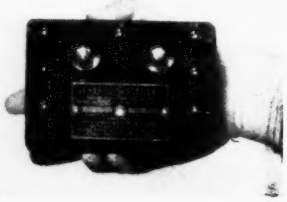
GRID boxes for each drive motor are mounted in fan-cooled metal cabinet with terminal board on outside in these speed regulating resistors for large a.c. wound-rotor motors. Grid boxes are wired at factory to provide motor speed characteristics desired, and





marked terminals are connected to match up with those on control panel.

General Electric Co., Schenectady, N. Y.



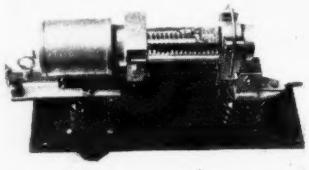
PHASE-ROTATION INDICATOR

PHASE-ROTATION indicator for 3-phase testing and installation work has no moving parts. Weighs 12 oz., and is 5½ x 3½ x 3 in. Pressing button lights two Neon glow lamps and phase-rotation, clockwise or counter-clockwise, is indicated when button is released, by which one of lamps remains lighted.

General Electric Co., Schenectady, N. Y.

FUSE

TYPE C fuse especially suitable for substations, industrial plants, cubicles and confined spaces where blowing of standard expulsion-type fuses might cause serious damage, has heavily constructed arcing chamber and condenser chamber at top of tube. Capacities range from ½ to 400



amp. for 7.5, 23 and 34 kv. systems.

Schweitzer & Conrad, Inc., 4435 Ravenswood Ave., Chicago, Ill.

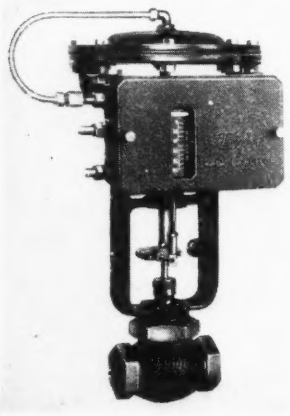
POTENTIOMETER PYROMETER

WIDE-STRIP pyrometer available in single-record, multiple-record and recorder-controller types operates on potentiometer principle of temperature measurement. Stainless steel, lead screw operated by electric motor under direction of two galvonometer-controlled contacts, adjusts slide-wire contact and recording-pen unit to maintain emf balance in potentiometer system. Pen movement is proportional to size of galvanometer deflection. Slide wire contact and recording pen mounted on same carriage. Uses 12¼-in. chart equipped with 1¼-in. indicating scale. Totally-inclosed dust-proof case. Catalog No. 1450.

Bristol Co., Waterbury, Conn.

VALVE CONTROL UNIT

PRECISION-valve-action unit for processes which have time lags or heat capacities demanding low or medium controller sensitivity, provided that load changes are negligible or infrequent. "Valve-Precisor" in case 8 x 5 x 2 in. can be mounted on any diaphragm valve and used in conjunction with air-operated controller. Must be located on diaphragm valve so that direct, rigid connection is maintained with valve stem. 25 lb. per sq.in. air or gas supply is recommended for most efficient operation.



Taylor Instrument Co., Rochester, N. Y.

REFRACTORY CONCRETE

HYDRAULIC insulating refractory concrete "Insulcrete" for poured refractory furnace linings and other industrial uses is said to possess properties of interlocking crystalline minerals, to have heat storage less than half that of fire brick, heat resistance up to 2,500 deg. F., low permeability, negligible shrinkage and expansion, high load carrying capacity and to weigh approximately 60 lb. per cu.ft.

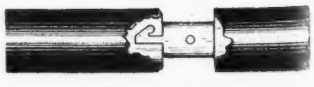
Quigley Co., Inc., 56 West 45th St., New York, N. Y.

WELDING CABLE CONNECTORS

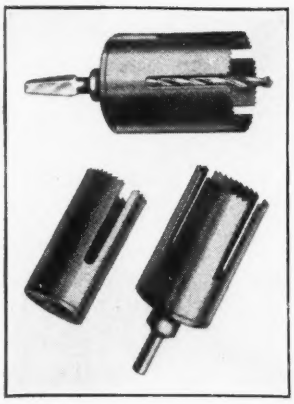
DETACHABLE cable connectors which permit welding cable to be made up in standard-length sections have metal parts machined from solid bar brass and insulated in special composition casing. Cable connected or disconnected by quarter turn of connector. Made in two ratings, 400 and 600 amp., each with and without solder connections.

Dallett Co., 165-189 West Clearfield St., Philadelphia, Pa.

Connector Locked



Connector Unlocked



PIPE-HOLE SAWS

FOR cutting holes for pipes through wooden floors, ceilings and partitions, these rotary pipe-hole saws have narrow slots in each cutter to provide an escape for sawdust as it accumulates. Cutters or saws are made of sufficient length to go through three thicknesses of flooring. In five sizes from $\frac{3}{4}$ in. to 2 in. May be used either in bit brace or in electric drill.

R. M. Starbuck & Sons, Hartford, Conn.

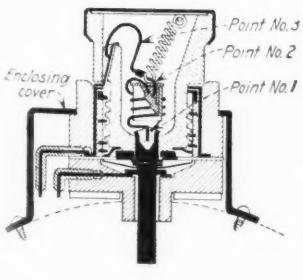
BRINE SYSTEM CORROSION CONTROL

SODIUM chrom glucosate, an alkaline organic chromate, is said to provide efficient corrosion control in brine systems, condenser systems and other water systems, where water is not used for human consumption, between a pH of 6 and 12. Available in 150-, 300- and 500-lb. drums, the material may be used in quantities of 50 lb. per 1,000 cu.ft. of calcium brine and 100 lb. per 1,000 cu.ft. of salt brine. Approximately 1 lb. for 20,000 gal. is required to treat average condenser water for chromate protection.

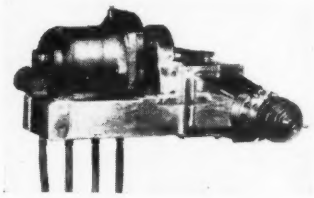
D. W. Haering & Co., Inc., 3408 Monroe St., Chicago, Ill.

THERMAL CUTOUT AND FUSE

PLUG type "Fusetrons" in sizes from $3\frac{1}{2}$ to 30 amp. combine overload protection of fuse with time-delay feature of thermal cutout. Made with Edison type tamper-proof bases and in cartridge form. Illustration shows tamper-proof base mounted on motor. When winding temperature reaches 96 deg. C. with normal current flow, fuse will open at point No. 1, overload will cause melting at point No. 2, and short-circuit will cause fuse to blow at point No. 3 Bulletin.



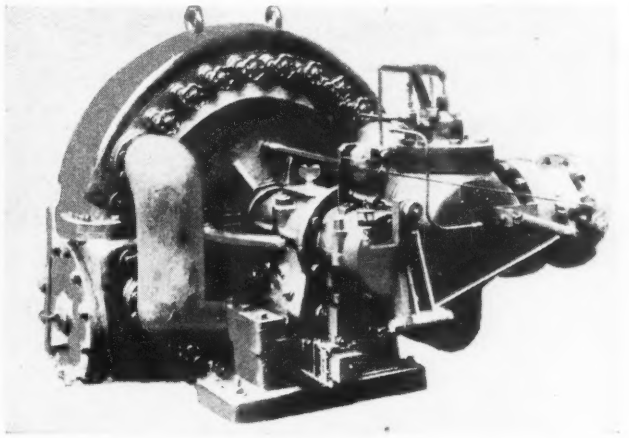
Bussmann Mfg. Co., University at Jefferson, St. Louis, Mo.



METAL SPRAY

METAL spray device for mounting on lathe tool post, or other holding fixture feeds standard-gage No. 9 wire at a rate of from 11 to 35 lb. per hr., driven by a 1/6-hp. motor. Uses acetylene gas, oxygen and compressed air.

Gillord Sales Corp., 420 Lexington Ave., New York, N. Y.



CENTER SUPPORTED TURBINE

TYPE BDE center-supported turbine permits casing to expand vertically, longitudinally or laterally without restriction. Longitudinal centerline construction comprises two heavy pedestals, one at coupling end cast in one unit with bearing housing, and bolting flange to support casing closely at horizontal center line; other at governor end cast in two units. Low pedestal with machined ways carrying bearing housing with bolting flange to support casing in similar manner as at coupling end.

D. E. Whiton Machine Co., New London, Conn.

RUBBER COVERING

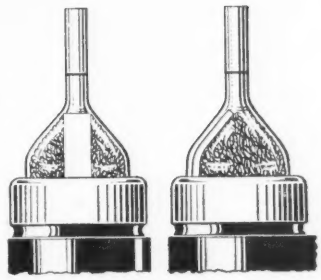
"SELF-VULC" rubber covering available in liquid or plastic form vulcanizes itself when exposed to the air. Applied after one coat of priming compound by brush, spray, dipping or pouring. Plastic form is applied with spatula or other flat tool. Used on inside and outside surfaces to resist abrasion, corrosion and acids, to absorb shocks and to silence noises. Bulletin.

Self-Vulcanizing Rubber Co., Inc., Room 515Y, 605 West Washington Blvd., Chicago, Ill.

NON-METALLIC BEARINGS

TEXTILE belting so woven as to combine wear on end-grain of fibres and strong binding together of fibres through length of bearing, is saturated with synthetic rosin, then formed into bearing shape under heat and pressure. Resin undergoes change from easily fusible and soluble material to ordinarily insoluble and hard material. Either water or oil is used for lubrication. Regular sizes from 4 to 30 in. in diameter in thickness $\frac{3}{8}$ in. up.

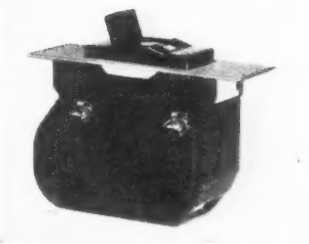
Joseph T. Ryerson & Son, Inc., Cleveland, Ohio.



ANALYZER VISION PANEL

TO IMPROVE visibility of solutions in absorption chambers of Orsat-type gas analyzers using fibrous material for surface absorption, this vision panel is made of opal glass and placed in front of chambers with space between panel and chamber wall for solution passage. Gives white background, close to wall of chamber.

Ellison Draft Gage Co., Inc., 214 West Kinzie St., Chicago, Ill.



125-VOLT CIRCUIT BREAKER

PRIMARY circuit breaker for outlet-box mounting provides short circuit and overload protection for 125-volt a.c. or d.c. circuits, and can also be used as switch control for branch circuits. For use in residence, apartment or business structures where localized control and access is desirable at convenient decentralized points, to re-establish circuits opened by overloads or other abnormal conditions. May be installed in standard square outlet box with raised cover and brass plate. Also suitable for gang mounting.

General Electric Co., Schenectady, N. Y.

WELDING CABLE

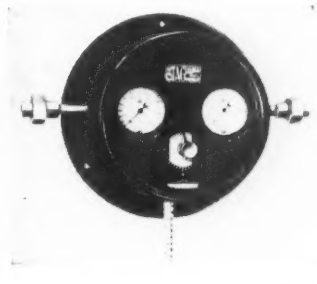
FINE tinned copper wire laid in ropes and stranded with individual ropes alternated in succession as regards direction of lay to prevent distortion in applications, this "Realwear" welding cable is insulated with rubber compound and uses cotton woven on a loom joined to rubber belt by special process for cover. Sizes from No. 2 to 4/0.

Lincoln Electric Co., Cleveland, Ohio.

CONTROLLER

SPRING lever multiplies movement of capsular spring in Tag No. 40 controller for majority of automatic control applications. Temperature change is transmitted to ball air valve which in turn resets rate of flow through diaphragm actuated control valve. Indicating and non-indicating types in nine temperature ranges and three pressure ranges are available. Bulletin No. 1127.

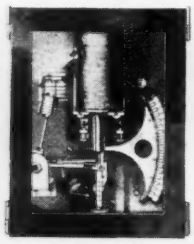
C. J. Tagliabue Mfg. Co., Park & Nostrand Aves., Brooklyn, N. Y.

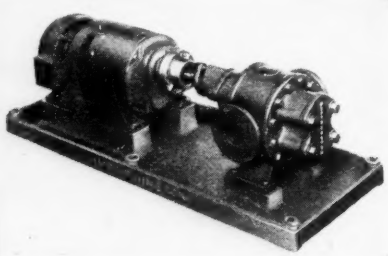


BOWL-MILL PULVERIZER

THE heading on the first article in the "What's New In Plant Equipment" section of October *Power* (Page 558), inadvertently referred to the device as a "Ball Mill Pulverizer." As the mill actually grinds the coal between reduction rolls and a grinding ring in a revolving bowl, as explained in the text, it really is a *bowl*-mill pulverizer. Four such mills have just been ordered to fire two new 315,000-lb. per hr. steam-generating units for Weirton Steel Co., announced last month in *Power*. Made by:

Combustion Engrg. Co., Inc., 200 Madison Ave., New York, N. Y.





VOLTAGE ADJUSTER

FOR small alternators in industrial and municipal installations, this type "V1" voltage adjuster can be applied to a.c. generators from 5 kva. at 360 r.p.m. to 250 kva. at 3,600 r.p.m., where voltage regulator requirements are not too exacting. $8\frac{7}{8}$ in. wide, 11 in. high and $9\frac{3}{8}$ in. deep, it embodies the "rocking contact" design, although uses solenoid operator in place of torque motor and an air dashpot in place of magnetic dampening.

Allis-Chalmers Mfg. Co., Milwaukee, Wis.

ROTARY PUMP

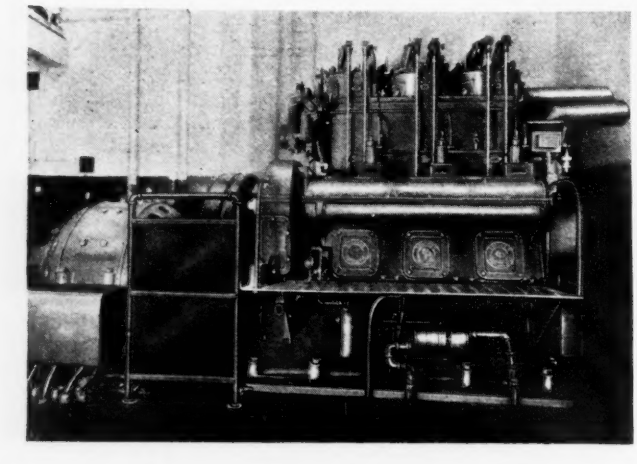
FOR pumping all clean liquids, including those that solidify when cool, such as asphaltum, this line of steam-jacketed pumps for pressures up to 300 lb. per sq.in., temperatures to 650 deg., has capacities from 10 to 2,500 g.p.m. Internal sleeve and roller bearings for non-corrosive liquids; external ball bearings for corrosive liquids. Continuous-tooth double - helical gear rotors, mounted on stiff shafts, with high-capacity bearings. Bulletin No. W-475-B8.

Worthington Pump & Machinery Corp., Harrison, N. J.

DIESEL ENGINES

Two classifications; general service and direct-connected for electric service. 4-cycle, direct-injection, pressure-lubricated type full diesel which may be converted to gas engine if desired with few minor changes. Use Bosch system of direct solid injection. Base or crankcase is of heavy box construction with ribs and cross-bracings for stiffness. Crankshaft open-hearth steel, die-pressed forging, heat-treated, then machined. Welded steel, water-jacketed, exhaust manifolds. Removable air-intake manifold fitted with flange to which silencer or pipe extension may be attached. Poppet-type air-starter valve with removable cage. Individual fuel pumps for each cylinder. Built in sizes from 100 to 800 hp. Bulletin No. 779.

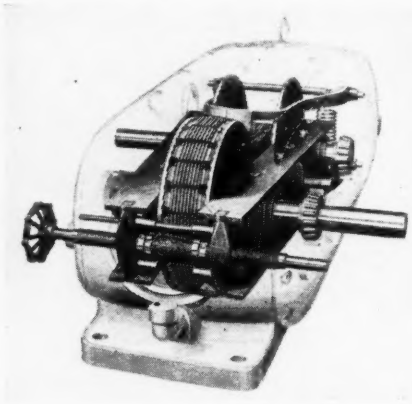
Chicago Pneumatic Tool Co., 6 East 44th St., New York, N. Y.

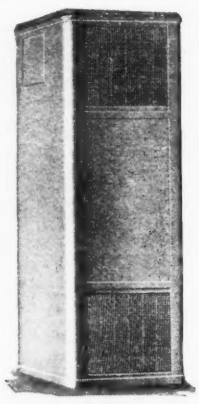


SPEED CHANGER

P.I.V. gear variable speed transmission now available in five sizes up to 15 hp. capacity, with integral motor if desired, with or without speed reduction gearing, with horizontal or vertical box. IN COMPLETE unit, power is transmitted from motor through reduction gears to input shaft of variable-speed transmission then through output gear reduction set to output shaft. Motor speed of 3,600 r.p.m. can be given speed range of 228 to 38 r.p.m. Book No. 1574.

Link Belt Co., 2045 West Hunting Park Ave., Phila., Pa.

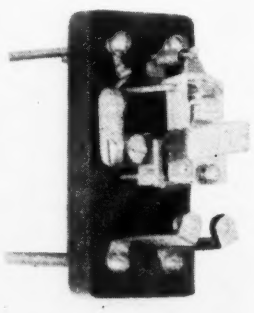




RESET RELAY

MECHANICAL latch, manual reset relay, for signal service, will allow operator to disconnect signal yet have circuit return to normal, when need for signal has passed, without further attention from operator. Provided with back contact so that contacts are open when coil is energized. Power failure causes relay contacts to close, energizing alarm circuit. Operation of reset lever disconnects alarm circuit by latching contacts open. When power is restored, relay armature picks up and locks contacts opened electrically, while allowing reset lever to return to original position.

Struthers & Dunn, Inc., 139 North Juniper St., Philadelphia, Pa.



JOURNAL LUBRICATOR

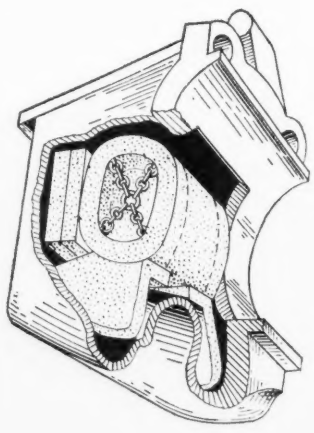
FOR lubricating axlecap and back shaft bearings, special sizes and shapes of "Stapax" resinous material are available. Oil is drawn up by capillary action from trough in bottom of housing, to bearing surfaces on shaft. Said to allow lower oil level in reservoir.

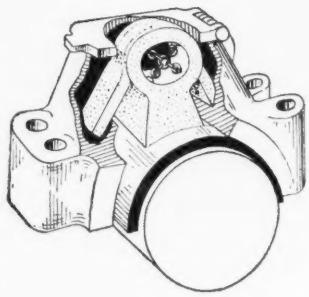
Lubrication Products Co., 1400 W. 25th St., Cleveland, Ohio.

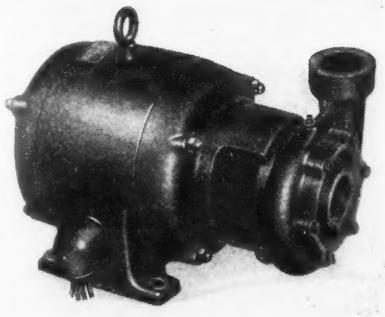
UNIT HEATERS

LINE of unit heaters includes floor line spread propeller types for ceiling and floor mounting, and ceiling, wall and floor types blower units known as "Torridor Series." Modernistic design, all corners rounded, with crinkle brown finish. Blower-type units feature Multiflex and Flexitrol to direct and control air flow. Multiflex grille may be attached to outlet nozzles of heater or over ducts for direct heat in various directions. Flexitrol consists of manually controlled dampers placed just above heating elements.

Trane Co., La Crosse, Wis.



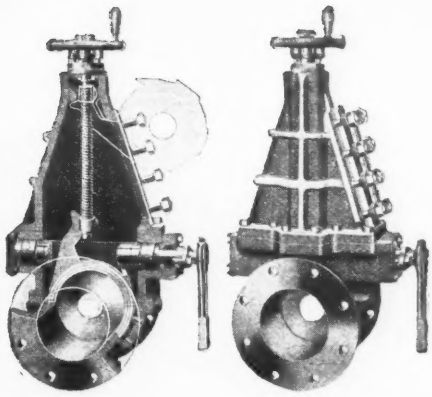




CENTRIFUGAL PUMP

OPEN impeller "non-clogging" centrifugal pumps for handling solid materials in suspension, gritty liquids, liquids containing stringy material, etc., made in wide range of sizes, are of rigid "Monobloc" construction. Available in all-iron, all-bronze, bronze-fitted, and such materials as stainless steel, Everdur and Monel metal. Ratings range from 10 to 250 g.p.m. against heads of 10 to 100 ft., ½ to 7½ hp., 1,500 to 3,600 r.p.m., a.c. or d.c., 50- and 60-cycle single- or polyphase. Bulletin No. W-321-B7.

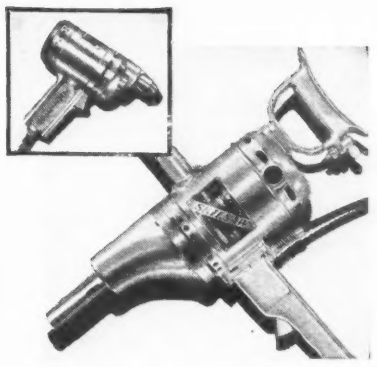
Worthington Pump & Machinery Corp., Worthington Ave., Harrison, N. J.



ORIFICE FITTING

FOR handling gases and liquids, orifice fitting has main operating mechanism of heavy stationary screw and follower nut pivoted to orifice-plate carrier, entirely inclosed in upper chamber. Device raises or lowers orifice-plate carrier and forces carrier into position in lower seats. For inspecting or changing, carrier is lifted completely out of upper chamber and held in convenient position for servicing. Valve seats are covered in both open and closed positions. Full-floating plug valve lubricated with equalized pressure system. Indicator shows when orifice plate is in position in pipeline bore.

Robinson Orifice Fitting Co., 1435 Santa Fe Ave., Los Angeles, Calif.



ELECTRIC DRILL

TWO small sizes, $\frac{3}{16}$ and $\frac{1}{4}$-in. electric drills for light work are 7½ in. long by $3\frac{3}{16}$ in. diameter with die cast aluminum alloy body. Two-pole switch inclosed in Bakelite. Speeds from 2,000 to 3,700 r.p.m. Also three large models, $\frac{5}{8}$, $\frac{3}{4}$ and $\frac{7}{8}$-in. have two bearings on armature, two on intermediate gear, and three on spindle. Helical-cut gears and die-cast aluminum housings.

Skilsaw, Inc., 3345 Elston Ave., Chicago, Ill.

LIFT-TYPE VALVES

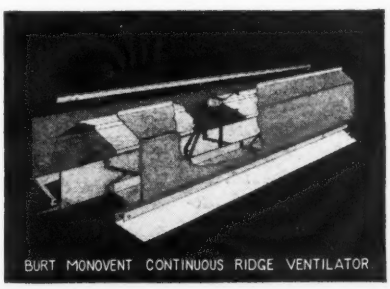
PLUG is lifted from seat in body a few thousandths of an inch to break friction between plug and body and allow free rotation on bearing surfaces in cast-steel lift type valves made in sizes from 1½ to 12 in. Screw action of lifting seating nuts presses ground, tapered, seating surfaces of plug and body together to seal against leakage. One-quarter turn to open or close. Made in straight-way, three-way and four-way types for pressures up to 1,500 lb. Reference Book No. 37.

Homestead Valve Mfg. Co., Coraopolis, Pa.

VENTILATOR

"MONOVENT Continuous Ridge Ventilator" made in seven sizes from 3 to 24 in. in 10-ft. lengths has inner deflecting baffle to prevent back draft from upward flowing air current and direct internal circulation to secure wind suction effect. Can be used on ridge, slope flat deck or built-up curbs. Damper operates vertically. Bulletin No. SPV-6.

Burt Manufacturing Co., Akron, Ohio.



ARC WELDER

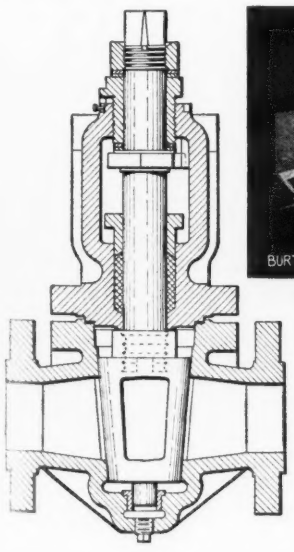
A.C. ARC welder for light metals down to 26-gage steels, complete with welding leads, hand shield and handles for portable use. Three sizes—15 to 150 amp., for $\frac{1}{16}$ to $\frac{5}{32}$-in. rods; 15 to 275 amp. for $\frac{1}{16}$ to $\frac{1}{4}$-in. rods, and "junior welder," 15 to 90 amp., for small power service. Welders have no moving parts and operate on 220-volt, 60-cycle, single-phase.

Miller Electric Mfg. Co., Appleton, Wis.

EDUCATIONAL X-RAY UNIT

FOR instruction and training of industrial students, this educational x-ray unit consists of a lead-lined cabinet enclosing a 200,000-volt x-ray generator and air-cooled tube. Rays escape through variable opening in top. Specimen box fits over top of base cabinet. Access doors and panels provided with safety switch.

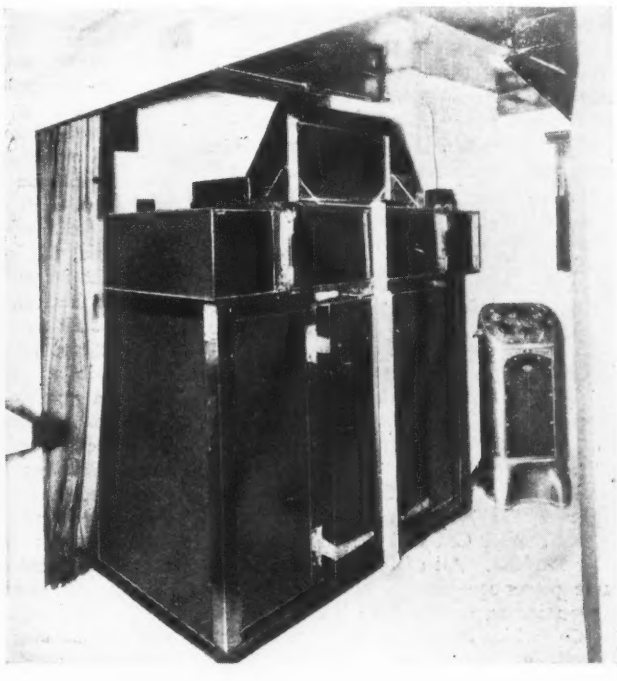
St. John X-Ray Service, Inc., 30-20 Thomson Ave., Long Island City, N. Y.



WELDING ROD

STAINLESS steel welding rod for welding chrome-nickel steels of 18-8 type, known as Oxweld No. 28 Columbium-Treated 18-8 Rod. Products fabricated are said to resist corrosion and heat without heat-treatment after welding.

Linde Air Products Co., 30 East 42d St., New York City.



A.I.S.E.E. CONFIDENT OF FUTURE

Power applications in the steel industry, public relations, new types of bearings and lubricants among subjects discussed

BUSINESS recovery was very much in evidence at the 35th Annual Convention of the Association of Iron & Steel Electrical Engineers at the Wm. Penn Hotel in Pittsburgh, Pa., Sept. 24 to 26. Not only was the convention highly successful and well attended, but the Iron and Steel Exposition, held in conjunction, was one of the most outstanding in the history of the association. Over 100 manufacturers of steel-mill and power equipment had exhibits that occupied all available exhibition space in the hotel.

Weirton Plant

A trip to the Weirton Steel Co. plant at Weirton, W. Va., attended by about 500 members and their guests, was one of the big events of the convention. This plant is one of the largest and most modern in this country, and includes all operations from blast furnaces to a wide variety of finished steel products. The plant has two power plants. The original one, at the tin-plate mill, comprises twelve 150-lb. boilers, having a total heating surface of 70,000 sq.ft.; and five turbine-generators with an aggregate capacity of 8,750 kw.

At the steel mill the main power-house has 23 fuel-fired 250-lb. boilers with a total heating surface of 162,000 sq.ft. and twelve waste-heat boilers on an equal number of open-hearth furnaces, some of which are the largest in the world. The fuel-fired boilers burn coal, coke breeze and blast-furnace gas. Of those burning solid fuel, some are fired by stokers and others by pulverized coal. All waste heat and fuel from the steel-making processes are utilized in steam production.

The steel-mill power plant comprises five 7,500-kw. turbine-generators, and an 80,000-c.f.m. and a 70,000-c.f.m. turbo-blower and two large blowing engines. In addition, the blooming mill is driven by one of the largest steam engines in the world.

Construction has been started on an extension to the steel-mill power plant, which will include two 900-lb., 815-deg. boilers, each with a maximum steaming rate of 400,000 lb. per hr., and a 12,500-kw. turbine-generator. The turbine will exhaust into the present 250-lb. steam header. When this unit is installed, electric power-generating capacity of the two power plants will be nearly 60,000 kw.

Progress Report

Technical sessions opened with the reading of a report on steel-mill developments by W. H. Burr, electrical and mechanical superintendent, Lukens Steel Co., Coatesville, Pa. This report records extensive modernization programs being made by Carnegie Steel Co., Bethlehem Steel Co., American Sheet & Tin Plate Co., Ford Motor Co., Republic Steel Co., and a steel company in New England. All of these projects include large power-equipment installations.

Outstanding among these is the Ford Motor Co., which includes a 7,000-hp. reversing blooming-mill motor and a 110,000-kw. turbine-generator, the latter to operate with 1,200-lb., 900-deg. steam.

When discussing power generation in steel plants, the report emphasizes the possibility of economies to be obtained by superimposed high-pressure plants, or "tops," upon existing medium-pressure plants. It is pointed out that these possibilities are sufficiently attractive to suggest close investigation. With the less-expensive electric power, the applications of mechanical power by steam will be less attractive, in many cases to the extent that some may show greater economy if changed to electric drive. Electric heat-treating, welding and other uses continue to add to the value of metal products and produce a higher electric consumption per unit of product, thus tending toward expansion of the electric power plant.

Bearings and Lubrication

Several papers were presented on composition, water-lubricated bearings on roll necks. These bearings are made of cotton duck fabric impregnated with a synthetic resinous compound and have several applications in the power field. Highly satisfactory results were reported with them where water at medium temperatures is available for lubrication. In one case in India, where lubricating water temperature was high, about 100 deg., serious difficulties were encountered with this type of bearing. Power savings up to 50% were reported with composition bearings compared to bronze types previously used.

A new type of oil-flooded babbitt-lined bearing was also described. Results with this design are highly satisfactory and show that bearings of this type, when properly designed and constructed, can operate with a high degree of satisfaction under almost any service condition.

Anti-Friction Bearings

At the lubrication and bearing session, O. L. Maag, lubrication engineer, Timken Roller Bearing Co., in "Lubricant Specifications, Their Development for the Steel Industry," described devices for testing lubricants and gave lubrication specification for various conditions.

In the case of anti-friction bearings, Mr. Maag said, the lubricant must act to reduce the slight internal friction in the bearings; dissipate heat; aid in keeping out foreign matter, such as water, scale, etc.; and prevent rust and corrosion.

Heat in an anti-friction bearing may be due to a number of causes. If the bearing is overloaded, distortion of races and rollers as they enter and leave the load zone may cause a serious rise in temperature. The use of too much or wrong-consistency lubricant may cause a rise in temperature. In some cases the surrounding atmosphere may reach a temperature actually injurious to the bearing, due to poor ventilation, etc. However, it is fundamentally the function of a lubricant to dissipate heat and protect the bearing.

In steel mills it is expected that the lubricant will aid in keeping foreign matter out of bearings. This, of course, is mainly done by the closures, but use of the correct lubricant will make the problem easier and operation more efficient. When the lubricant is expected to function in part as a seal and prevent entrance of foreign matter, it is essential that proper-consistency lubricant be selected. Special emphasis should be given in this case to the requirement that the lubricant should not thin out too much in service.

The highly polished steel surfaces of anti-friction bearings are easily attacked by rust and corrosion, and the lubricant must prevent this attack, thereby maintaining the smooth surface so essential to friction-free service. In this connection, it is well to add a word of caution to operating men to watch their lubricants and see that they always come up to specifications for their intended application. The laboratories can be of great value to operating and maintenance departments in this connection.

One of the important meetings of the convention was devoted to industrial relations between employer and employee and safe operation. The speaker, Arthur H. Young, vice-president, United States Steel Corp., was introduced by Charles R. Hook, president, American Rolling Mill Co. Mr. Hook emphasized the importance of safe operation, and said that safe operation was efficient operation. It was his experience that when a plant made a record for safe operation it also made a record for high production.

Taking for his text "The Human Element in Industry Is the Factor of Greatest Importance," Mr. Young said that on these eleven words hang all the law of the prophets of the American industrial gospel. They point and illumine the pathway toward, if not all the way, an industrial relation which shall produce a more durable peace, a sounder progress and a truer prosperity than our peaceful, progressive, prosperous industrial America has yet enjoyed.

As an example as to what industrial plants have done to give the employee security on the job and security in old age, Mr. Young said that the U. S. Steel Corp. had expended more than 60 million dollars in direct pension payments to its retired employees. Thousands of its employees are today the owners of homes bought under its home-ownership plan, and its employees are carrying more than 300 million dollars of life insurance at a cost to them of $9 per year per thousand dollars.

FUEL CONSUMPTION

TOTAL production of electricity for public use in 1934 in the U.S. was 91,150,000,000 kw.-hr., 37.4% generated by water power, and 62.6% by fuel. Of the proportion produced by fuel, 80.2% was produced with coal, 13.1% with gas, 6.4% with oil and 0.3% with wood. Best 1934 fuel rates were 0.8 lb. coal per kw.-hr., 450 kw.-hr. per 42-gal. barrel of oil, 11 cu.ft. of gas per kw.-hr. Average fuel rate is now 1.47 lb. of coal per kw.-hr. for the U. S., as compared with 1.94 lb. in 1926 and 1.55 in 1931.

DIESELS BELOW ZERO

Modern cold room containing temperature control for testing engines at temperatures as low as 20 deg. below zero enables Electric Storage Battery Co., Philadelphia, Pa., to determine starting problems of diesel engines at various temperatures and under various conditions

POWER LINES

A.S.M.E. Annual Meeting

MANY papers of interest to power engineers will be presented at the A.S.M.E. annual meeting, Dec. 2-6, at Engineering Societies Bldg., 29 West 39th St., New York, N. Y. Some of these are:

TUESDAY, DEC. 3

Hydraulic Session, 9:30 a.m.

Problems in Hydraulic Design Arising from Study of Cavitation, by W. Watters Pagon.

Progress Report on Cavitation Research at M.I.T., by J. C. Hunsaker.

Progress in Cavitation at Princeton, by Prof. L. F. Moody and Asst. Prof. A. E. Sorenson.

Power Session, 2 p.m.

Cause and Prevention of Turbine Blade Deposits, by F. C. Straub.

An Airfoil Type Propeller Blower for Ventilating Electric Machines, by C. E. Peck, M. D. Ross.

Process Session, 2 a.m.

Influence of Double Eddy Current on Design of Dust Collectors, by H. von Tongeren.

Hydraulic Session, 2 p.m.

Cavitation Testing of Model Hydraulic Turbines and Bearing on Design and Operation, by L. J. Davis.

Cavitation Testing on Propeller Pumps, by Prof. A. Tenot, translated by L. S. Kerr.

Creep of Metals Session, 2 p.m.

Design Aspect of Creep, by R. W. Bailey.

A Method of Analyzing Creep Data by R. G. Sturm, C. Dumont, F. M. Howell.

The Creep of Metals, by A. Nadai and E. A. Davis.

Residual Stresses in Cold-Drawn Brass Tubes, by O. G. Anderson.

WEDNESDAY, DEC. 4

Power Session, 9:30 a.m.

Steam Turbine Testing (A proposal to use Impact Pressures and Temperatures).

Flow Characteristics of Variable Speed Reaction Turbines, by A. Egli.

Viscosity of Water and Superheated Steam, by G. A. Hawkins, H. Solberg, A. A. Potter.

Power Session, 2 p.m.

Stresses in Three Dimensional Pipe Bends, by Wm. Hovgaard.

Creep Strength of Steels as Influenced by Microstructure, by L. L. Wyman.

Boiler Furnace Session, 2 p.m.

An Experimental Investigation of Heat Absorption in Boiler Furnaces, by W. J. Wohlenberg, H. F. Mullikin, W. H. Anmacost, C. W. Gordon.

Critical Review of Methods of Computing Heat Absorption in Boiler Furnaces in the Light of Data Presented in Part 1, by W. J. Wohlenberg, H. F. Mullikin.

An Empirical Method for Solving for Heat Absorption in Boiler Furnaces, by H. F. Mullikin.

Fan Test Code Session, 2 p.m.

Measurement of Air Flow in Fan Inlet and Discharge, by L. S. Marks.

Definition of the Quantity-Head Characteristics of Fans, by M. C. Stuart, W. E. Somers.

THURSDAY, DEC. 5

Fuels Session, 9:30 a.m.

Factors in the Selection of Coal for Underfeed Stokers by Committee on Fuels.

Symposium on Zoned and Metered Air Control for Underfeed Stokers, by H. E. Macomber, A. S. Griswold, J. N. Landis.

Fuels Session, 2 p.m.

Life of Various Types of Furnace Bottoms for Tapping Ash in Molten State, by Rolfe Shellenberger.

Water-Cooled Stokers, by J. S. Bennett and C. J. Herbeck.

Electrostatic Precipitators for Stoker-Fired Boilers, by C. W. Hedberg.

Costs Session, 2 p.m.

Industrial Production Costs, by C. H. Knapp.

Power Distribution Costs, by Morris L. Cooke.

Oil and Gas Power Session, 2 p.m.

Film Lubrication Theory and Engine Bearing Design, by W. S. Dennison.

Ignition and Combustion of Diesel Fuels, by G. D. Boerlage and J. J. Broeze.

Oil Engine Electric Generating Station Operating Costs, by Geo. C. Eaton.

1934 Cost Data Report.

Boiler Feed Water Session, 2 p.m.

Use of Solubility Data to Control the Deposition of Sodium Sulphate or its Complex Salts in Boiler Water, by W. C. Schroeder, A. A. Berk, E. Partridge.

Estimation of Dissolved Solids in Boiler Water by Density Readings, by J. A. Holmes, J. K. Rummel.

Suspended Solids in Foaming and Priming of Boiler Water, by Prof. C. W. Foulk.

Embrittlement of Boiler Steel by Caustic Soda, by G. H. Wagner, J. R. Wall.

Study of Effect of Concentrated Sodium Hydroxide on Boiler Steel Under Tension, by A. S. Perry.

Radiation from Non-Luminous Flames, by H. C. Hottel, V. L. Smith.

Ford of Canada Adds Capacity

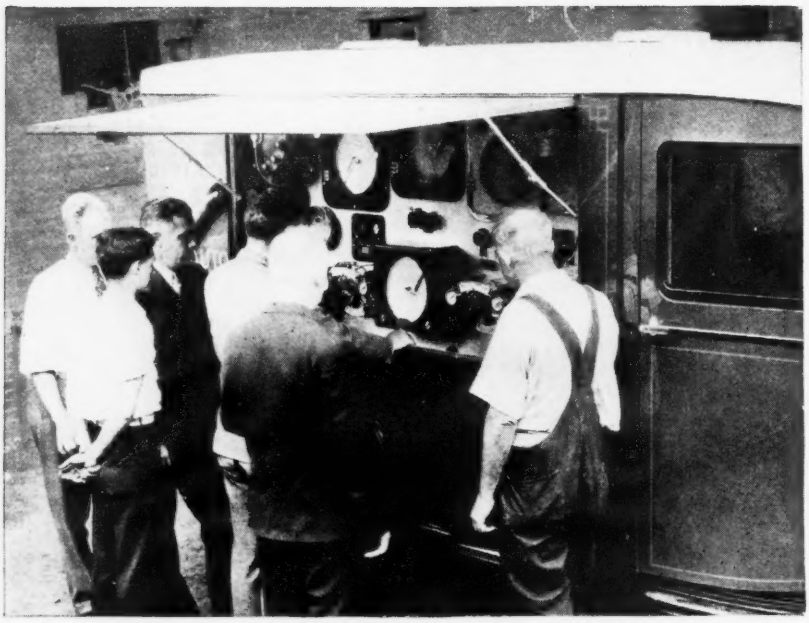
Ford of Canada, East Windsor, Ont., has invited bids for power house equipment to cost approximately $2,000,000 in a plant modernization program which will double existing capacity. Provide for more electric power and additional steam supply for processing and plant heating. Program includes installation of three turbo-generators, 20,000 kw., 5,000-kw. and 750-kw. rating, and two 900-lb. pressure, 850-deg. boilers, the first to be in operation about Jan. 1, 1936. No structural changes in the present power house on Sandwich St., East Windsor, other than interior changes for heavier foundations for machines, etc. Installation will be conducted in a series of steps, so power and steam production will not be halted. First step will be installation of a 180,000 lb. steam per hour bent tube boiler by about Jan. 1. 5,000-kw. non-condensing turbo-generator, to take steam at 800 lb. pressure, 800 deg., and exhaust into present 10,000-kw. machine at 200 lb. pressure, will be next. Connection between two machines will be bled to obtain steam at 200 lb. for shop processes.

A.S.T.M. Committee on Gaseous Fuels

American Society for Testing Materials has organized a standing committee to undertake certain standardization and research work in the field of gaseous fuels. A. C. Fieldner, chief engineer, Experiment Stations Division, U. S. Bureau of Mines, was elected permanent chairman of the committee. R. M. Conner, director, American Gas Assn. Testing Laboratory, as secretary, and R. B. Harper, vice-president, Peoples Gas Light & Coke Co., was chosen vice-chairman. Main subjects selected for immediate development are: Collection of Samples, Measurement of Samples, calorific value, specific gravity or density.

Acetylene Meeting

Thirty-sixth annual meeting of International Acetylene Assn. will be held in Cleveland, Nov. 12-15. The keynote speaker will be Merle Thorpe, editor of *Nation's Business*. Industrial play, "Profits of Progress," which was so successful at meeting last year in Pittsburgh, is to be repeated in Cleveland. F. H. Reinhart, 30 East 42nd St., New York, N. Y., is secretary of the Association.



ROVING SHOWCASE

Field Demonstration Service for control equipment used by Mason-Neilan Regulator Co., Boston, Mass. Specially designed truck, equipped with reducing valves and control instruments, is making a nationwide tour, giving demonstrations

Power Output at New Peak

Central station power output has been at an all-time high for three consecutive weeks ending Oct. 19, at about 1,863,000,000 kw.-hr., rising to 1,867,127,000 kw-hr. in the week ending Oct. 12. This is a gain over 1934 of about 12% and 3.5% over 1929.

Air Conditioning for Hershey Windowless Building

Hershey Chocolate Corp., Hershey, Pa., is completing a large 3-story office building without windows which accurately controls temperature, humidiy and modern lighting to make occupants of building entirely independent of daily variations in weather. Air-conditioning system (135-ton capacity) will automatically supply air at proper temperature and humidity for all seasons. Two separate air-washing systems will maintain 80-deg. dry-bulb temperature with 65-deg. wet-bulb temperature in summer, and 75-deg. dry-bulb temperature with 48% relative humidity in winter. Circulation of conditioned air at 90,000 cu.ft. per min. Building 151 ft. wide and 308 ft. long, has basement and three stories above ground. Roof is level concrete deck, where there will be about 2½ in. of water at all times, for insulation.

AMERICAN STANDARDS ASSOCIATION has approved 1935 edition of National Electrical Code published by National Board of Fire Underwriters, and has listed it as ASA project C1.

BUSINESS NOTES

BYLLESBY ENGINEERING & MANAGEMENT CORP. recently elected the following men to its board of directors: J. F. Owens, president of Oklahoma Gas & Electric Co., Frank R. Phillips, president of Philadelphia Co., Pittsburgh, Robert F. Pack, president of Northern States Power Co., T. B. Wilson, president of Louisville Gas & Electric Co., J. P. Pulliman, president of Wisconsin Public Service Corp., W. F. Raber, president of San Diego Consolidated Gas & Electric Co., C. M. Brewer, president of Mountain States Power Co., and California Oregon Power Co., and W. N. Clark, president of Southern Colorado Power Co.

W. A. KENNEDY Co. has been appointed representative of McClave-Brooks Co., Scranton, Pa., in North Carolina, South Carolina, Georgia, and eastern Tennessee, to the western boundary line of Claiborne, Union, Anderson, Roane, Rhea and Hamilton Counties.

PAUL B. HUYETTE CO., INC., Philadelphia, Pa., has appointed Charles T. Kemp, Jr., Preston St. & Guilford Ave., Baltimore, and Frank W. Hoyt, Scranton Life Bldg., Scranton, Pa., as district representatives.

KENT-ERVIN ENG. CO., 732 Builders Exchange Bldg., Minneapolis, Minn., has been appointed agent for Elgin Softener Corp., Elgin, Ill., to serve Minnesota and northwest Wisconsin and North and South Dakota.

H. W. PORTER & CO., Newark, N. J., have appointed the following distributors: Reid Hayden, Inc., Baltimore, Md.; Brooks-Fisher Insulating Co., Atlanta, Ga.; Asbestos Construction Co., New York, N. Y.; Johns-Manville Sales Corp., Albany, N. Y.; Smith-Murray Corp., Syracuse, N. Y.; Asbestos & Magnesia Materials Co., Chicago, Ill.; Aycock Corporation of Texas, Houston; Johns-Manville Sales Corp., Dallas, Texas; Indiana & Kentucky General Asbestos & Supply Co., Inc., Indianapolis, Ind., and Louisville, Ky.; Johns-Manville Sales Corp., Hartford, Conn.; Milwaukee Insulation Co., Milwaukee, Wis.; The Nicely Corp., Philadelphia, Pa., Taylor-Seidenbach, Inc., New Orleans and Birmingham; Johnson Asbestos Co., Springfield, Mass.; Johns-Manville Sales Corp., St. Louis and Kansas City, Kans., Johns-Manville Sales Corp., Tulsa, Okla.; Johns-Manville Sales Corp., Omaha, Nebr.

AMERICAN HAMMERED PISTON RING CO., Baltimore, Md., has signed a contract with Skinner Chuck Co., New Britain, Conn., to cooperate in the manufacture and sale of "Gold Seal" and "Silver Seal" piston rings.

REPUBLIC STEEL CORP. has moved its Pittsburgh district sales office from 4th and Bingham Sts. to 1832 Oliver Bldg. F. M. Welsh continues in charge, assisted by his present staff. Union Drawn Steel Co., a Republic subsidiary, will move into an adjoining suite. W. C. Gullyea, district sales manager, will be in charge.

GENERAL ELECTRIC CO., Air-Conditioning Department, Bloomfield, N. J., has appointed E. J. Opal, former manager of merchandising division, manager of Gas Furnace and Air Circulator Division. E. B. Shiddell has been appointed assistant to manager of Air-Conditioning Department in charge of dealer operations.

BABCOCK & WILCOX CO. has opened a sales office at 1809 Railway Exchange Bldg., St. Louis, Mo., under F. C. Brant, formerly of the Chicago office to serve the eastern half of Missouri and the southern section of Illinois.

FARRELL & JONES, 10 High St., Boston, Mass., have been appointed Boston representatives of Griscom-Russell Co.

PETER A. FRASSE & CO., INC., have been appointed sales representatives of Lebanon Steel Foundry in New York, Connecticut, New Jersey, Delaware, Maryland, Virginia and Pennsylvania east of Altoona.

HYDROSTATIC ENGINEERING CO., LTD., has been incorporated at Victoria, B. C., as a provincial company of hydraulic engineers. It is capitalized at $100,000 and has registered offices at 902 Birks Bldg., 718 Granville St., Vancouver, B. C.

BANTAM BALL BEARING CO., South Bend, Ind., has become a subsidiary of Torrington Co., Torrington, Conn. Bantam will continue operations as usual in factory at South Bend.

FULLER CO., Catasauqua, Pa., has acquired from F. L. Smidth & Co. exclusive rights to "Fluxo" system for conveying pulverized materials in the United States and possessions, Canada and Mexico.

CATERPILLAR TRACTOR CO. has appointed Paul Weeks, formerly manager of the Washington office, to succeed Walter H. Gardner as manager of the special sales division, when Mr. Gardner leaves the company to become general sales manager of Keystone Steel & Wire Co. Assisting Mr. Weeks will be C. L. McMullen in charge of engine sales to manufacturers, and G. E. Spain in charge of power unit sales to distributors and engine dealers.

PERSONALS

GEORGE L. KNIGHT, vice-president in charge of mechanical operations of Brooklyn Edison Co., has been elected president of United Engineering Trustees, Inc. Mr. Knight has been vice-president and chairman of the finance committee for the last two years, and before that was a member of the board of trustees. Other officers elected were H. G. Moulton, first vice-president; Otis E. Hovey, second vice-president; John Arms, secretary, and Albert Roberts, assistant treasurer.

HORACE GOLDSTEIN, former resident manager of the Boston office of Link-Belt Co. has been assigned to engineering sales work at the Philadelphia office.

SMITH L. RAIRDON has been appointed eastern sales manager, with headquarters in New York City, of Owens-Illinois Glass Co., Toledo, Ohio.

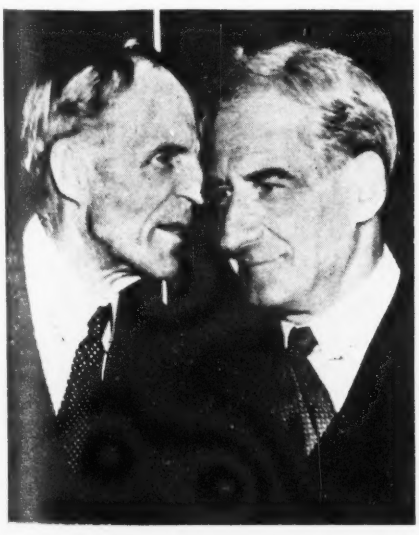
FRANK F. CHILES, formerly manager of sales of the Bar Division, Corrigan, McKinney Steel Co., has been appointed assistant manager of sales of the Bar Division, Republic Steel Corp., with headquarters at Youngstown, Ohio.

JOSEPH M. BANDISH has been appointed director of sales of metallic packing division of Felt Products Manufacturing Co., with offices in Felts Products Building at 1508 Carroll Ave., Chicago, Ill.

JOSEPH F. SHADGEN, former associate of C. H. Smoot, manufacturer of regulating equipment, has drawn up preliminary plans for the 1939 World's Fair to be held in New York. The project will cost about $40,000,000, and has received the approval of the local authorities.

CHARLES F. SCOTT, professor-emeritus of electrical engineering, Yale University, and chairman of the board appointed by Governor Cross to administer the recently enacted engineers' registration law in Connecticut, has been elected chairman of Engineers' Council for Professional Development. Professor Scott succeeded C. F. Hirshfeld, chief of research of the Detroit Edison Co., who has served as the Council's chairman since its formation.

DAVID A. CHAPMAN, former director of the smoke prevention division for metropolitan Boston and consulting engineer in that city from 1922 to 1929, has been appointed assistant to the president of the Carter Coal Co., Boston, Mass.



CONFIDENTIALLY

Henry Ford and Gerard Swope at the General Electric Works, where the 110,000-kw. turbine is being built for Ford's River Rouge Station. Henry Ford, Edsel Ford and several Ford officials spent a day there looking over the first large unit to operate at 1,200 lb. pressure and 900 deg. F. Mr. Ford met the Board of the General Electric Co., went through the "House of Magic," and telephoned his manager in Buenos Aires and his home in Detroit while driving down the road in a tricked-up Ford.

E. A. CHILDERHOSE, senior engineer, U. S. Engineers, Missouri River division office, Kansas City, who has been in charge of designs at the federal power development at Fork Peck, has been transferred to the Passamaquoddy tide power project at Eastport, Me.

WM. M. BLACK has been elected vice-president in charge of sales of American Manganese Steel Co., Chicago Heights, Ill., Mr. Black joined the company in 1912, and became eastern sales manager in 1927, and in 1934 was appointed general sales manager at Chicago Heights, where he still has his office as vice-president.

MELVIN D. ENGLE has been appointed superintendent of the Station Engrg. Dept., Edison Electric Illuminating Co., Boston, Mass., to succeed George E. Seabury, retired.

JOHN F. GLENN, formerly with Wickes Boiler Co. and Edge Moor Iron Co. has been appointed to the New York Sales Division of Foster-Wheeler Corp. During the World War, Mr. Glenn was connected with the War Industries Board at Washington, and in charge of priority applications for powerhouse equipment.

WILLIAM GODBEY has been appointed representative for Kennedy Valve Mfg. Co. in Kansas, Nebraska, western Missouri and southwest Iowa, with headquarters in Kansas City, Mo.

WILLIAM A. ROWE, formerly of American Blower Co., has joined the staff of the Aerovent Fan Co., Piqua, Ohio, to initiate and develop the airfoil design of a new line of fans.

FRANK WEBSTER, formerly of the Philadelphia office of Link-Belt Co., has been transferred to Boston, Mass., as New England sales representative with headquarters at 20 Providence St.

V. L. SANDERSON has been appointed sales representative for the American District Steam Co. in Philadelphia and Delaware with headquarters at 1108 Otis Building, Philadelphia, Pa.

TRYGVE D. YENSEN, engineer in charge of the Magnetic Division of Westinghouse Electric & Mfg. Co. Research Department, and N. A. Zeigler received the Henry Marion Howe medal awarded Oct. 3 by the American Society of Metals in Chicago.

HARRY RALPH RICARDO, F.R.S., has been nominated Melchett Medallist of the Institute of Fuel (Great Britain) for 1935. Mr. Ricardo, in his address dealt with matters connected with gasoline and diesel engines.

JOHN D. SWAIN, former vice-president of Linde Air Products Co. and Union Carbide Sales Co., has been elected vice-president of Electro Metallurgical Sales Corp., 30 East 42nd St., New York, N. Y.

LOWELL O. STEWART has been appointed personnel officer for the Division of Engineering, Iowa State College, and will supervise all personnel work in this division.

JAMES O. WICK, JR., president and general manager, Falcon Bronze Co., Youngstown, Ohio, and director of American Foundrymen's Assn., has been elected vice-president of the Association to fill the vacancy occasioned by the death of B. H. Johnson.

JOHN PRIMROSE, former vice-president of Foster-Wheeler Corp., since its organization, has been elected vice-president of the board, following the resignation of Harold W. Foster, who will continue as a director. In 1901 Mr. Primrose became chief engineer of Power Specialty Co., and subsequently vice-president in charge of oil refinery activities. When Foster-Wheeler Corp. was formed, Mr. Primrose was elected a vice-president, which office he has held until the present.

OBITUARIES

FRANK A. HATCH, 58, president of Shepard-Niles Crane & Hoist Corp., Montour Falls, N. Y., died October 15. Mr. Hatch graduated from University of Michigan in 1900, and three years later came to Montour Falls as treasurer of Pneumatic Tool Co. In 1917 he became vice-president and general manager of its successor, the Shepard Electric Crane & Hoist Co., and in 1929 was elected president and a member of the executive committee of the Shepard Niles Crane & Hoist Corp. He was also a director of the Niles-Bement-Pond Co., New York, N. Y.

JULIAN E. WOODWELL, 61, New York consulting engineer for 25 years and member of A.S.M.E., A.I.E.E., A.S.T.M., and I.E.S., died Oct. 23. Mr. Woodwell was at one time in charge of electric light and power plants in all Federal buildings. From 1909 to 1913, with his partner, L. B. Marks, he designed and installed the mechanical and electrical equipment in the New York Post Office.

GEORGE ARTHUR EVANS, 63, engineer and chief electrician at Massachusetts State Prison, Charlestown, Mass., died September 20.

FRANK M. SHELDON, 75, head of Braman Dow & Co., Boston, Mass., and connected with that organization for the past 50 years, died September 20.

ALBERT S. SMITH, 66, superintendent of power and buildings at Massachusetts Institute of Technology from 1904 until his retirement in 1933, died September 20.

WILLARD M. SMITH, 49, chief load dispatcher for utilities of the Tenney system north of Boston, with headquarters at Eastern Massachusetts Electric Co.'s offices in Salem, since 1925, died recently. He was formerly connected with the Simplex Wire & Cable and Cambridge Electric Light Cos.

G. S. WORTLEY, sales manager of Imperial Electric Co., Akron, Ohio, since 1913, died September 13.

STRAWS

Pointing the way business winds blow

South and Southwest

BRUNSWICK, GA., plans early bids for municipal electric plant, distribution lines and street-lighting system. Financing through Federal aid. J. F. Ahern, 2355 Post St., Jacksonville, Fla., consulting engineer.

ROCKY MOUNT, N. C., plans construction of transmission line, distributing lines, power substation and service facilities for electrification in a number of rural districts in vinicity of city, to use service from municipal power plant. Project estimated to cost $87,000. Bond issue has been authorized.

DIXIE ICE CO., Clearwater, Fla., plans ice-manufacturing and refrigerating plant. Cost over $45,000. Headquarters at Tampa, Fla.; D. Arias, president.

SOUTHERN INDUSTRIES & UTILITIES, INC., has withdrawn its application concerning the Aurora dam on the Tennessee River near Kentucky-Tennessee line, with the concurrence of the TVA, to which the applicant has transferred its right, recently valued by the Federal Power Commission at $156,490. A dam at or near the Aurora site is part of TVA's plan for ultimate development of the river.

DANVILLE, VA., city council is preparing to act swiftly following passing of the bitterly fought acceptance campaign for a PWA bond issue of $1,513,000, which, with a Federal grant of $1,237,909, assures Danville the development of hydro-electric resources at The Pinnacle in Patrick County.

ROANOKE (VA.) GAS LIGHT CO., 121 Church Ave., has authorized artificial gas plant at Winchester, Va., including pipeline, estimated to cost close to $60,000. R. C. Huffman, president, in charge.

MEDFORD ICE CO., Medford, Okla., plans extensions in ice-manufacturing plant, including new equipment. Cost close to $25,000. E. S. Henry, general manager.

TARRANT, ALA., has secured PWA loan and grant of $328,000 for distribution system, including substation for connection with TVA transmission lines. Work to begin soon. Roy Ingram, mayor, active in project.

PURE ICE & COLD STORAGE CO., Lake Charles, La., plans ice-manufacturing and cold storage plant at Cameron, La. Estimated to cost over $45,000, including equipment.

Lake States

JANESVILLE, MINN., plans municipal electric plant, including distribution system and service facilities. $105,500 through Federal loan and grant.

BECKETT PAPER CO., Hamilton, Ohio, plans steam-electric power plant for mill. Cost over $200,000, with equipment. Proposed to ask bids soon. Fosdick & Hilmer, Union Trust Bldg., Cincinnati, Ohio, consulting engineers.

BERESFORD, S. D., has secured $70,700 through PWA grant and loan for proposed municipal electric plant and distributing lines. Plans soon.

U. S. ENGINEER OFFICE, Rock Island, Ill., receives bids until Nov. 14 for lock power and control system at Lock and Dam No. 18, Mississippi River, near Burlington, Ia. (Proposal 61).

JOHNSON CITY, ILL., will take bids early in December for new municipal electric plant, including distribution system. $210,300 has been secured through PWA loan and grant. Loewensohn, Pearson & Solomon, 6 North Michigan Ave., Chicago, Ill., consulting engineers.

MONARCH BREWING CO., 2419 West 21st St., Chicago, Ill., has filed plans for new one-story addition to boiler house, 46x49 ft., estimated to cost about $24,000, with equipment, and will start work soon.

DETROIT, MICH., Board of Education plans large boiler plant for central heating of multi-story Western high school building, for which plans were arranged by Smith, Hichman & Grylls, Marquette Bldg., Detroit. $1,100,000 has been authorized for entire project. Bids soon to be asked.

SIMRALL PIPE LINE CO., Mount Pleasant, Mich., plans construction of welded steel pipeline from Crystal oil-field district, Montcalm County, Mich., to Toledo, Ohio, about 140 miles, for crude-oil transmission to refinery of Standard Oil Co. of Ohio. Line will be built under direction of Franklin Tool Co., Mount Pleasant, and will have initial capacity of about 25,000 bbl. per day. Project will include series of pumping and booster stations, to cost about $1,200,000. C. L. Maguire president of first company.

REEVES PULLEY CO., Columbus, Ind., has marked the third addition to both office and factory space since the first of the year by adding 3,500 sq.ft. to its machine shop.

CHILLICOTHE (OHIO) Board of Education, is completing plans for new steam plant for central heating of two school buildings, and will begin work soon. $27,500 has been secured through Federal aid.

PFEIFFER BREWERY has purchased from Kroeschell Boiler Co., Racine, Wis., through Acme Equipment Co., Inc., Michigan, a new 5,020-sq.ft., 4-drum, bent-tube, water-tube boiler, equipped with Fire-Rite stokers.

WASHBURN, WIS. Board of Bayfield County Commissioners, plans steam power house for central heating service to cost over $30,000, with equipment. Thomas J. Shefchik, Glencoe Bldg., Duluth, Minn., architect.

MANITOWOC, WIS., plans installation of new prime movers and auxiliary equipment in municipal electric plant for large increase in capacity. $441,000 secured through Federal aid. Public Utilities Commission, Peter Eastman, president, in charge.

CAVE SPRINGS DISTILLING CORP., Newport, Ky., Albert Mayer, president, care of Glazier & Morlidge, 305 Walnut St., Cincinnati, Ohio, engineers, recently organized, plans steam powerhouse in connection with new multi-unit distillery near Newport. Entire project will cost close to $200,000.

Mid-West

HOPKINTON, IOWA, is arranging fund of $67,800 through Federal aid for power plant including distribution system. Plans will be drawn at early date, and bids for equipment asked. Diesel-generating units are under consideration.

IOWA CITY, IOWA, will soon take bids for electric plant, including steam-electric generating units, boilers, pumps and auxiliary equipment, transformers, switchboard, instruments, etc., as well as distribution system. Project will cost about $900,000, $400,000 for station equipment. Burns & McDonnell Engrg. Co., 107 West Linwood Blvd., Kansas City, Mo., consulting engineer.

UNITED POWER & IRRIGATION DISTRICT, Cambridge, Neb., recently organized by Henry L. Mousel and Lloyd C. Richardson, both of Cambridge, and associates, is consummating plans for power and irrigation project in Red Willow and Furnas Counties. Diversion dams on Medicine Creek and Republican River, with hydro-electric generating station on last-noted stream near Indianola, Neb. are planned. Development estimated to cost $940,000. Financing through Federal aid.

WHITE EAGLE OIL CORP., Federal Reserve Bank Bldg., Kansas City, Mo., has approved plans for first section of new 100-mile welded steel pipeline in the Western Kansas oil fields, comprising a section of about 40 miles from Burrton Hollow oil area, Reno and Harvey Counties, Kan., to Chase, Kan. Contract awarded to Smith Construction Co., El Dorado, Kan. Cost over $500,000.

MO. STATE BUILDING COMMISSION, Jefferson City, Mo., has authorized plans for power plants at State Hospital at Nevada, Mo., and School for Feeble-Minded, Marshall, Mo., for central heating. Surveys and estimates of cost will be made at once, followed by call for bids. Black & Veatch, 4706 Broadway, Kansas City, Mo., consulting engineers for former, and Powers & Wells, Security Bldg., St. Louis, for Marshall station. Charles A. Haskins, Finance Bldg., Kansas City, Mo., is supervising engineer for both plants.

PANHANDLE EASTERN PIPE LINE CO., 101 West Eleventh St., Kansas City, Mo., will soon proceed with surveys and plans for welded steel pipeline from Dana, Ind., to Detroit, Mich., for natural gas for Detroit City Gas Co., with which a 15-year contract recently has been consummated. Line will be about 300 miles long, comprising 24-in. welded steel pipe. Construction to begin early in 1936, with completion by July. To cost about $9,000,000. In addition, Panhandle company plans improvements in present pipe line from Texas fields to Dana, including new welded steel pipe and other strengthening and reinforcement work, to cost over $5,000,000. Detroit City Gas Co. is perfecting plans for extensions and revisions in present artificial gas distributing lines and facilities to accommodate new increased service which calls for a maximum of 90,000,000 cu.ft. of natural gas per day; new mixing and distributing station will be constructed. Cost about $2,000,000. Panhandle company is subsidiary of Columbia Oil & Gas Corp., both being controlled by Columbia Gas & Electric Co., New York.

MACON, Mo., has Federal aid for fund of $80,000, for extensions and improvements in electric plant and distribution system. Baumes & McDivitt, Railway Exchange Building, St. Louis, Mo., consultants.

WEBSTER CITY, IOWA, plans extensions and improvements in municipal artificial gas plant, to cost about $38,000.

NEBRASKA MUNICIPALITIES plan power projects. Blair will soon take bids through Black & Veatch, 4706 Broadway, Kansas City, Mo., consulting engineers, for diesel station to cost $60,000. Potter will make extensions and improvements under D. C. Shea. Imperial plans bids for equipment including pumping station, for which plans are being completed by H. H. Henningson Engrg. Co., Union State Bank Bldg., Omaha, Neb., consulting engineer, estimated to cost $66,700. Financing through Federal aid. Woodlake has secured $20,000 through Federal aid, and proposes early call for bids through A. S. Harrington, Baum Bldg., Omaha, consulting engineer.

East

NAVY DEPARTMENT contracts for the building of submarines Nos. 182 to 187 have been awarded to United States Navy Yard, Portsmouth, Me., and Mare Island, Calif., and at shipyards of Electric Boat Co., Groton, Conn. Winton Engine Co., Cleveland, Ohio, will provide three diesels, and Hooven-Owen-Rentschler Co., Hamilton, Ohio, the other three. Electrical equipment for all six will be built by Elliott Co., Pittsburgh, Pa. Total contract with Winton Engine Co. is $2,288,145; with Hooven-Owen-Rentschler, $2,447,232. Elliott Co.'s share in both contracts is considerably over $1,000,000.

ROCHESTER (N. Y.) GAS AND ELECTRIC CORP. will put into service, about Dec. 1, at Station No. 3, Mill St., a new unit operating at high pressure and temperature, superimposed on units in existing plant. A 250,000-lb. per hr. boiler utilizing pulverized coal will supply steam at 650 lb. and 750 deg. to a 6,000-kw. turbo-generator unit. Turbine will exhaust at 215 lb., 535 deg. F., into the present 210-lb. gage steam header, and furnish enough steam to generate something over 15,000 kw. at this lower pressure.

LYNN GAS & ELECTRIC CO., Lynn, Mass., has contracted with Stone & Webster Engrg. Corp., for design and supervision of construction of additional boiler capacity. Cost $600,000, includes extension to existing boiler house and installation of boiler to generate about 205,000 lb. of steam per hour, together with auxiliary equipment.

LANSDALE, PA., has purchased a 3,750-kw. Elliott turbine-generator with two extraction stages. Scofield Eng. Co., Philadelphia, Pa., was retained to draw up specifications and plans and supervise installation. Elliott extraction heaters and a heat exchanger operating in conjunction with a continuous boiler blow-down system were included.

BOSTON (MASS.) ICE CO. has filed plans for new one-story cold storage plant on Massachusetts Ave., to cost close to $30,000.

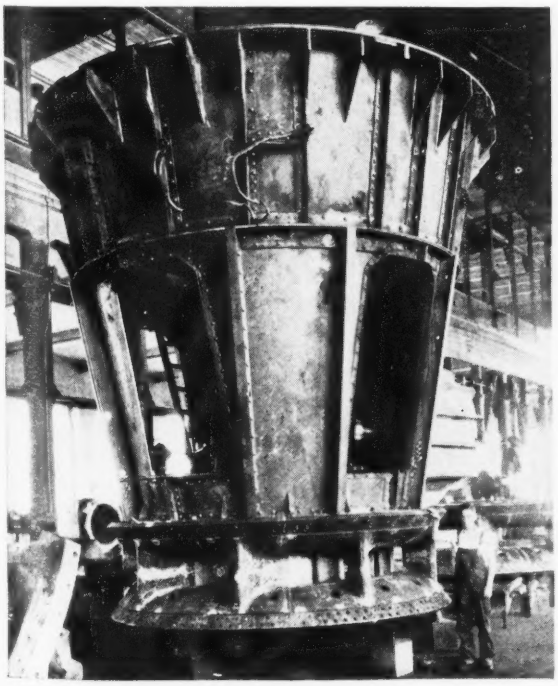
MILFORD, CONN., plans electric pumping station for new sewage-treatment plant, for which $207,450 for entire project has been secured through Federal aid. Bids soon.

BUREAU OF YARDS & DOCKS, Navy Dept., Washington, D. C., plans power plant in connection with new drydock at Puget Sound Navy Yard, Bremerton, Wash., for which appropriation of $4,500,000 has been approved; of this amount, close to $500,000 will be used for power station and auxiliary service structures.

West

SEBASTOPOL APPLE GROWERS' UNION, Sebastopol, Calif., plans cold-storage and refrigerating terminal to cost close to $60,000, with equipment. To ask bids soon. E. C. Merritt is general manager.

STANDARD OIL CO. OF CALIF. has authorized Stone & Webster Engrg. Corp. to design and construct steam power stations to supply major portions of process steam and electrical requirements for refinery at Richmond, Calif. Cost approximately $1,300,000. Boiler units will be designed for high pressure, to supply steam to turbines exhausting at pressures suitable for use in refinery processes. Electrification program will cost approximately $500,000.



SPEED RING

Speed-ring generator support welded and riveted of structural and plate steel for one of three 17,000-hp. S. Morgan Smith hydraulic turbines being installed in the Mantaro, Peru, plant of Cerro de Pasco Copper Co. Units will operate under 250-ft. head in this Andes mountain plant 12,000 ft. above sea level. Ring is riveted to plate-steel scroll case and whole structure is cast into concrete foundation. Steel structure transmits weight of generator to speed ring

PAROWAN, UTAH, has begun expansion and improvement program in municipal power plant and waterworks system. $76,000 has been authorized. Caldwell & Richards, Templeton Bldg., Salt Lake City, Utah, consulting engineers.

U. S. ENGINEER OFFICE, Portland, Ore., awarded contract to General-Dhea Construction Co., Henry Bldg., Portland, for powerhouse substructure and superstructure, including control-station structures and auxiliary works for Bonneville, Ore., hydro-electric power project; total cost of $1,923,651.80.

SUSANVILLE, CALIF., plans distribution system, transmission line, and substation. Entire project will cost close to $100,000.

SPRECKELS SUGAR CO., 2 Pine St., San Francisco, Calif., plans power plant in connection with new beet-sugar refinery on site in Yolo County. Cost over $500,000. C. J. Moroney is general manager.

LEWISTOWN, MONT., is considering installation of distributing system for natural-gas service, including welded steel pipeline for supply service from fields at Armells, Mont. Cost $230,000. Federal aid.

RICHFIELD, UTAH, plans municipal electric plant to cost $150,000, including distribution system and power substation. Work soon. Financing through Federal aid.

WEEPAH NEVADA MINING CO., Weepah, near Las Vegas, Nev., has concluded arrangements with Nevada-California Power Co., Riverside, Calif., for 8 miles of transmission line from near Las Vegas, for new mine and mill operation. Cost about $30,000.

LAS VEGAS, NEV., is concluding arrangements for $250,000 bond issue for municipal electrical utilities, including high-tension transmission line to Boulder Dam, Nev. Project is being developed either for construction of new municipal power plant to cost about $206,000, with equipment; or for acquisition of local power station of Southern Nevada Power Co., with appraised value of $148,200, and extensions and improvements.

Foreign

LADYSMITH, B. C., COUNCIL is now making arrangements to survey Holland Creek for possibilities of developing local hydro power. The creek is believed capable of developing from 200 to 250 hp. for nine months, and that better storage and diversion facilities at headwaters could be maintained to supply current during dry seasons. City already owns generating equipment which could be used.

QUESNEL, B. C., LIGHT & POWER CO. has commenced trail and camp construction on Baker Creek, four miles above its confluence with the Fraser River, preparatory to erection of new hydro-electric plant to furnish light and power for Quesnel and surrounding district. Work under the direction of A. F. Peers. 30-ft. dam, power house and transmission line are proposed. Initial unit will be 200 hp. at 5,600 volts, to be ready by Nov. 15. Three lakes at head of creek offer storage facilities and the stream is estimated to be capable of developing 1,000 hp. David Grierson is managing director.

SWEDISH total consumption of water power last year was 1,980,000,000 kw.-hr., an increase of 180,000,000 kw.-hr. over 1933.

COPY CAT...

It's probably a hangover from my kid days, but I can never quite trust a "copy cat"—the boy who does something because everybody else does, who says something because everybody else says it, who believes something because everybody else believes it. Maybe the fellow out in front does get the hard knocks, but he's also in the best position to see where he's going.

I suppose it's my kid hatred of copy cats that gets me where I live every time somebody spouts, "No, we haven't got so-and-so, but this is just as good." If I ask for a Robert Burns, I don't want an El Ropo; if I ask for Listerine, I don't want Formula 66. I'm not out to buy just so much of whatever it is, I'm out to buy that product plus pioneering experience and service. Maybe I will pay a little more for the experience and service, but I know what I get won't let me down.

The same idea holds when I buy clothes, food, toothpicks or equipment or supplies for the plant. When I buy a steam engine I don't want to buy just so many hundredweight of cast iron; I want to buy so many years of experience and service. I believe that any nut can design a trademark, but it takes dependability to keep it alive. I know that a familiar trademark means efficiency built in and trouble built out.

My job is providing power and steam. I could furnish horses or mules that have the same power I put on wires, and I could build bonfires that would provide the same amount of heat as my steam. But they wouldn't do the job we want them to. For our job they'd just be substitutes.

My power and steam go into the making of a nationally advertised product. That trademark is well known and respected, and has been for years. We've gone a long way out of our way to keep it that way—if we slip, we've got a lot to lose. If we have, so have most of the others, something I can't be sure of with substitutes. Furthermore, it's just as important that we producers of nationally advertised products use nationally advertised equipment—if we go to nondescript products, so will our purchasers.

Emerson it was, I think, who explained about building a better mousetrap and how the world would beat a path to your door. Two things Mr. Emerson forgot—the first that you have to tell somebody about it or nobody will start the path, and the second that among the first people to follow the path will be some who will steal your pioneering vision and experience and make a mousetrap that's "just as good." The question is not whether his mousetrap is just as good or whether the path to his door is shorter, but whether his trap will catch more mice. If it won't, it's just counterfeit, and counterfeits never paid dividends for very long.

Maybe it's luck that some trademarks last and some fall by the wayside. But I'm inclined to believe that luck is about 99% perspiration and 1% inspiration, and I'm willing to pay for somebody else to perspire if it will save me sweat. If the known names are lucky, then I want them to bring me luck, too. After all, I'm the guy that is going to use the stuff I buy, and if I can't depend on it, I'm going to flop by one heck of a long ways in getting my money's worth out of it.

Probably it's all these things banging around in back of my head that make me want to take a poke at the guy who stands up and says, "Mister, this here's just as good!"

George Edwards

GEORGE EDWARDS
Engineer